X-Ray and High Frequency in Medicine

BURDICK

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PREFACE

This volume is dedicated to my wife. It is due to her tireless energy that much of the material has been collected. During my busy life I have had very little time to devote to the collection and arrangement of facts that are necessary in a volume of this size. It was she who has made note of the various series of experiments that I have carried on in the last twelve years.

We have very little to offer that will be new to old operators, no startling discoveries have been made concerning the X-ray itself; since Roentgen's last paper, we have gained much knowledge concerning it, and it has made steady advances in its application, and the end is not yet.

In this book the reader will find my individual opinion, it contains my personality, as far as possible I have tried to give credit where credit is due, I have drawn freely from the literature of the age, and am under many obligations to the archives of the Roentgen Ray for its excellent translations of foreign papers. It appears the American physician will not support a journal upon this special subject, and the many valuable papers by American operators have appeared in many obscure medical journals, and have been lost to the great majority of physicians.

Some of the matter presented has been published in the Wisconsin Medical Recorder, and has been revised and brought up to date. I have purposely left out some well-known processes, involving the use of the Fluoroscope in diagnosis, as the Orthodiagraph and kindred methods, owing to its danger to both operator and patient.

I have spoken with the freedom of the class room and no one can read the volume without having much food for thought.

In physics we are just beginning to attack the great mountain of truth, that when known will make all the world kin.

Any physician who wishes to take up this work from the proper motives, should spend a year studying physics before he attempts to use it.

In the X-ray we have the most wonderful therapeutic agent known for a small number of diseases, that have baffled medical science. If it is properly used results not before known in medical science will be obtained; if not used with discretion, disaster and humiliation are sure to follow. The more perfect the operator's knowledge of electricity and physics, the more likely will he be successful. I have observed several times an operator who knew absolutely nothing about the process, yet under a happy combination of circumstances, he was wonderfully successful; as might be expected it did not last. Others I have seen who were hard students and very painstaking where success was delayed for many years. All of my medical life I have worked for physicians, and individually I probably know him, his trials, temptations, and virtues, as well as any other man, and I am convinced that he has not reached the higher ideal demanded by the Divine Spirit of Medicine. He is not the great force in our civiliation, he should be, and he as an individual is alone to blame.

THE AUTHOR.

THE PHYSICS OF THE X-RAY

A Foreword.

The physics of the X-Ray must date back to the marvelous conception of the Greek Philosopher Thales, five hundred years before the Christian era. In the mind of this man was born the germ of modern physics. He conceived the idea that all matter possessed a soul, similar to the animal. He observed the regular order of crystallization to be found in all solids, and came to the conclusion that the phenomena could be accounted for only on the theory that matter possesed an intelligence of a lower order than that observed in the animal kingdom.

He endeavored to find facts during his life to support his contention, but without avail, until he came into possession of a piece of Amber. This he found apparently responded to external stimulation in such a manner as to justify his inference that a special intelligence could be shown to be present. If he rubbed it vigorously with a silk cloth, he aroused anger, and it would reject light bodies with a snapping sound, while its spirit was appeased by rubbing it with other substances, so that it would attract them to it, thus showing to Thales' mind that matter can appreciate kind treatment or resent indignities.

This experiment, born of the Molecular Theory, brought into the world a new force, known by the general term of **Electricity.** Galvani, Volta, Faraday, and numerous others had to come and go before this wonderful plaything became a stern reality in the physical and industrial world. Its wonderful development, step by step, as the mind of man unravelled mystery after mystery, each adding its mite to the material facts, until, in the course of twenty centuries, the simple, puzzling experiments of a simple philosopher have been converted into a living, pul-

sating personality, that has done more for the human race than all other discoveries combined.

It has conquered the gigantic waterfalls; it has dammed the great rivers; it has run galleries beneath the mountains and into the bowels of the earth; it has recovered and transformed the immense work of the sun during the uncountable ages, and has resurrected and reanimated that long sleeping energy, and has reconverted it into a living, pulsating force for the good of suffering humanity.

It has changed the long, tiresome journey into a luxury that the very poorest human being can enjoy; it has carried light into darkness, and in no small way has turned night into day. It is running our factories, handling with a fine degree of precision the gigantic machine tools that turn out the large war machines, locomotives, and mining machinery so necessary to our complex civilization of today, and with equal precision, takes the place of the tired housewife at the wash-tub, or the sewing machine, and does her work with tireless, uncomplaining energy.

It has annihilated distance, and has enabled the human family to be united in thought, although separated by thousands of miles; it has adopted the whole world and made all kin. It brings us a tale of human suffering, of human sorrow, of great distress, of love, wars and jubilations from the four corners of the earth. The heart throbs of our brothers have been made to synchronize with our own—we hear his cry for bread, the wail of sorrow, as of Rachael weeping in the wilderness and would not be comforted because they were not.

It brings us the best and the worst thoughts of mankind, the latest discoveries, songs or poetry. It tells us of the triumphs and failures of our greatest, and plays upon our heart throbs like a skilled musician upon an instrument.

It has taken on seven-league boots and now leaps through the ether, bringing a tale of shipwreck and disaster to their brothers upon the land, and carries back words of cheer to the despairing souls, as they are told of

the Herculean efforts being put forth to rescue them from their peril. No matter how fierce the elements, or thick the fog, our faithful servant is willing to do the bidding of its human masters.

It has already conquered the earth, and has begun to sweep the universe, looking for others of our kind upon the millions of unknown worlds that we know occupy space. It would be a rash man who can predict the end of its usefulness, or its limitations.

We are apt many times to look at the great things done by our servants and forget the small; we are carried away with its great achievements and forget that this giant force can stop at the bed of suffering, and after shedding its benign beneficence over our patient, again impart the spark and energy of life that changes our despairing, suffering brother into a well and strong member of society.

Is it not well to study this useful agent, learn its laws, and get a mental grasp upon its possibilities, that we may use them usefully in the alleviation of human suffering? No small mind can grasp the great truths that are taught us by this great force. It is useful for either good or evil; it will stretch forth its energy to save life, or will kill with equal impunity at the will of its master—there can be no half way about its capabilities and it will work equally as well for good or evil.

Electricity—To give my readers a mental grasp upon this subject will be a difficult undertaking, owing to many reasons, principally because some forms of thought are difficult to transfer from one human brain to another, but the more perfectly we understand the subject, the more wonderful our results will be in its use. We must look upon electricity as a form of motion, a motion that takes place in the invisible world around us, but nevertheless, as interesting to observers as anything that takes place in our everyday life.

Molecular Theory—Under this name, we embrace all that is known regarding the minute world that exists around and within us,—this world, within which the Cre-

ator wrought. The conception of this theory has grown apace, in order to keep up with the wonderful discoveries announced from time to time by different members of the great human family. We have not taken much from the original theory, but have been compelled to add more from time to time, to enlarge it to cover existing conditions.

Matter—All matter is made up of particles called molecules. These are complex bodies, made up of smaller particles called atoms. This sufficed for many years to explain Chemical Phenomena, but eventually it was found that the atoms varied widely in size and weight, as well as the molecule, so that we soon found that our molecule might contain all the way from three atoms in simple compounds to as much as forty-five thousand atoms in one more complex. The atoms were also found to vary considerably in size, from the simple Hydrogen Atom to its heavier Uranium, Chromium and Platinum prototype, so that in order to make the theory fit conditions, it was necessary to assume that each atom must be derived from an elementary compound, so we divided all the known forms of matter into about eighty elements, and assigned an atomic weight to the atoms from each element. This sufficed for the enormous development of modern chemistry and was not seriously questioned for many years although a chemist or physicist would call attention to phenomena that was apparently impossible with such a large body as an atom was known to be. That matter must exist in some smaller form was understood, yet as no means was at the command of the chemist by which he could destroy the atom, no serious thought was given to the matter until eventually the physicists began to examine the phenomena described and discovered by Faraday, of the behaviour of the electrical current in a sealed tube from which the air had been partly exhausted.

Sir William Crooke, having carried the exhaustion of the tube further than other physicists, eventually disassociated or disintegrated the atom, and believed he had made

a new discovery of matter called "Radiant." As the phenomena that took place in his tube could have not taken place with as large a body as an atom, eventually it was conceded that he had destroyed the atoms and that the phenomena was due to the "fragments" of the atom.

The names of Hittorf, Hertz, and Lenard, appear before Roentgen made his astounding discovery of the X-Ray. This focused the attention of the physical world upon the phenomena of the vacuum tube and the bodies within these tubes were investigated and weighed by the scales of mathematics, and it was found that the tubes' contents were bodies with weight, that had physical properties all their own. This led to a modification of the molecular theory by the discovery of the corpuscles.

Corpuscles—These minute bodies, whose existence was suspected by many, but succeeded in eluding many of the keenest minds for many years, were at last discovered, and it only remained to ascertain their properties.

By calculating the arc of deflection by a magnetic field of known strength in the cathode stream, their weight and volume was found to be one one-thousandth times less than the Hydrogen atom. It was found that they normally carried a negative charge of electricity, but would take on a positive charge when brought in contact with a polarized electrode. Moreover, as will appear later, they have weight and can carry and deliver energy.

Radioactivity—The wonderful discovery of radioactivity again riveted attention upon these bodies and led to a further elaboration of the molecular theory. The one accepted practically without question today by the greatest living Physicists is as follows:—

Molecular Theory — The molecule remains without change, but the atom has become a very complex body. In other words, it is now looked upon as a miniature Solar system, made up of a great number of corpuscles, which obey the electro-magnetic pulse of the universe and swing around their orbits in a similar manner to our own solar system. Stranger still, under our present conception, the

elements are disappearing and the atoms are now made up of a certain number of these negative corpuscles, which unite in certain mathematical ratios to form an element.

For instance, the Hydrogen atom contains one thousand of these corpuscles, which unite and form an electrical equilibrium, the so-called cohesion of the chemist. The Oxygen atom contains sixteen thousand of these corpuscles, and so on up the scale until we have the Platinum atom, with one hundred and forty-nine thousand corpuscles, held within its structure.

The world of possibilities opened up by this conception is not appreciated by other than a scientific mind. If it means anything, it means that we shall be able to take our food, heat and power from the atmosphere above and the earth beneath! it means that we shall clothe ourselves, make our own diamonds, gold, silver and precious stones by synthetic means; it means the ultimate relief of the human race from the misery of the sweat-shop and the tyranny of greed; it will lift the mind of man from material things to the highest conception of life.

These thoughts are not entirely based upon speculation, but are foreshadowed by experiments that have already been performed and justify a profound study of these bodies, the "primordial dust" that was used by the Creator in His work, and the study of electricity as the force with which these wonders were performed.

Electricity, Conception of—If we conceive of this force as a mode of motion, we must get a grasp upon its form. Experimental evidence shows us that this form of energy causes things to rotate and that the so-called vortex motion is the form ascribed to it. We have a force, a quantity, and a resistance to overcome in this mode of motion, and as we see it taking place in a conductor, we assume that the corpuscles arrange themselves in rings under the polarizing force of the current, and a rotation takes place.

Electro-Motive Force—These rings rotate in two different directions under the influence of both a positive

and a negative manifestation of this form of energy. The number of times we cause these rings of corpuscles to rotate in a second's time determines our electro-motive force.

Amperage—The number of rings that rotate in a second's time give us our ampere flow, so that we must cause them to rotate at a higher rate of speed to increase our electro-motive force, or cause more of them to rotate if we desire to increase the quantity of current.

Positive Motion—A right-handed rotation gives us a positive flow of current, this not having reference to the way the observer is standing, but to the actual direction.

Negative Motion—A left-handed rotation gives us a negative flow of current.

Now we cannot have a positive, but we must have a negative in the near vicinity, so that in a charged conductor we have a form of motion in both directions at one and the same time.

Conductor—These are usually some soft ductile metal or fluid which allows its corpuscles to rotate under this twisting force.

Insulators—These are usually a hard, vitrified or elastic material that under the application of this force, allows the atoms alone to become polarized, turning them at right angles to their normal plane, but preventing their complete rotation; they act much like a coiled spring. They store energy and will restore it when the strain is removed.

Resistance—All forms of energy must overcome opposition in order to develop power. In the steam boiler, it is the power of the shell to prevent the escape of the polarized steam. In electricity, it is the work of turning the corpuscles in the different conductors over which it is compelled to pass, and in order that we may have a yard-stick to measure this resistance, we have taken an arbitrary unit called an Ohm. This means the amount of work that would be required in turning the corpuscles in a column of mercury 106 centimeters in height, one millimeter in diameter, and at 15 degrees centigrade. This unit is

standard anywhere upon the earth's surface, slight variations taking place by radical changes of pressure of the atmosphere.

A Volt is the unit of twisting force required to turn enough of the corpuscles in this column of mercury to give us an ampere of current, and gives us the formula known as the **Ohm's Law** ($C = E/R$) which will be more fully explained further on.

Amperes—The product of the number of corpuscles that are moving in a second's time, and is determined by the amount of metal the current will remove from one electrode and deposit upon another in a given length of time. The atomic weight of the metal deposited must be ascertained to prevent error, as silver is the standard metal used in determining these values.

Polarity—One of the first phenomena that strike the ordinary observer forcibly is the striking difference between each pole of a conductor, and as he gets deeper into the subject, his wonder will increase. If we take some source of current for experimental purposes, and prepare a number of bottles with a weak acid solution, and cut our conductor in such a way that the fluid in each bottle must become a part of it, we will see that gas is given off at the end of each wire. If we collect the gas from the most active pole, we will find its volume just twice that of the less active pole. If we test its atomic weight, it is one. It burns with a blue flame, is intensely alkaline in reaction; turning litmus paper blue, and when mixed with air, it explodes violently: If we test its polarity, we will find it with a negative charge, so that we know that we have Hydrogen gas, and we call this pole the Negative, alkaline, or stimulating pole.

Positive Pole—If we now collect the gas from the other less active electrode, we find its atomic weight to be 16, intensely acid in reaction, with a Positive charge, and while it will not burn, it supports combustion. We know that we have Oxygen gas, and call the pole the Positive, acid or sedative pole.

Here we have, by means of energy, torn apart a chemical compound formerly regarded as, and even now called the elements, and have found it to be made up of two dissimilar gases, each of them differing in every physical property from each other—one acid, the other alkaline; one positive, the other negative, and, according to the laws of both physics and chemistry, having the greatest possible affinity for each other, and yet we can mix them in the same container, and leave them as a mixture for years without the slightest combination taking place, until we suddenly apply some form of energy, as a flame, a blow, an electric spark, or some catalytic substance, (like spongy platinum) when suddenly they unite with explosive violence, showing the great affinity these gases have for one another, and we have completed a cycle of events.

We have given sufficient proof of our molecular theory, as we have torn apart by energy a compound, have weighed and investigated the physical properties of its parts, and by the application of energy have again combined them.

Catalysis—This is a remarkable phenomenon, and is common in both the physical and chemical world. Many remarkable substances have this property, and they are of the greatest importance to mankind.

If we take a piece of spongy platinum, and pour over it alcohol, we have acetic acid. The platinum does not enter the combination, but by its mere presence makes this union possible. The platinum is not changed a particle in composition, but its corpuscles have been made to move at a higher rate of speed, as is shown by the increased temperature.

Lead—Curiously enough it is the elements with the complex atoms that seem to give off their energy under suitable conditions, and lead is one of the most useful. In the manufacture of sulphuric acid, the retorts must be lined with lead in order to make the acid economically. No lead enters the combination with the acid, but it makes its production commercially possible.

Enzymes are another form of matter that can give off energy without becoming destroyed. Most physicians evidently labor under the error that Pepsin enters into the combination called Peptones in the stomach, judging from the great quantities given patients, but here, as with the metallic substances, they cause the change without entering into it themselves.

Corpuscles in Solution—M. Rodin, of Paris, in experimenting with the corpuscles obtained by means of an alternating arc current between silver electrodes immersed in distilled water, succeeded in obtaining these corpuscles in solution, and was enabled to investigate their properties from a physiological standpoint. He reports that they have enzyme properties and are exceedingly active from a medical standpoint.

This I have verified with the ions of mercury in bad cases of syphilis, used by injection within the veins, and the ions from uranium and zinc have been used in cancer, and with enough tangible results to justify further investigation along this field, which is fraught with the greatest importance to the human race, and will repay study. Many of nature's secrets are concealed within these bodies, and no man can foresee what investigations will bring forth.

Polarity—If we take a conductor and support it in such a way as to prevent the current from leaking to the earth, and heat one end by a flame, both ends being connected to a sensitive galvanometer, we will find that we will get a current of electricity that flows through the conductor in one direction, and will continue to flow just as long as a slight difference in temperature exists between both ends of a wire. When the vibrations of the atoms are the same in both ends of the conductor, no current will flow, and if we suddenly cool the end we were heating, we will find that the current will pass just the same, but in the opposite direction. This gives us a good idea of the origin of this force. Whenever we have an unequal motion of the

atoms in a conductor, there we have a current of electricity

If we will take this same conductor and mount it upon glass, so as to prevent the escape of any current to earth, and disconnect our galvanometer, we will get polarity. In other words, polarity means an electric current sufficiently insulated from the earth, or from its other complement, so that it cannot escape, it begins to run around the conductor, gradually gaining in electro-motive force, until it will attract or reject light bodies, or it may become so great that a spark may pass between the separated poles, or to the earth, so that our definition of polarity means an insulated electric current, under a stress or strain.

Polar Characteristics—Positive Phenomena. Where this form of motion leaves a conductor, it disintegrates it and carries its atoms bodily from the conductor through a fluid or semi-fluid medium to the opposite conductor, upon which it deposits its burden. No current can pass without a certain amount of disintegration of the conductor, the amount depending upon the actual value of the current passing in a given time.

Sedative Pole—There gathers around the positive pole oxygen gas which produces an intensely acid condition of the neighboring tissue when used as a therapeutic measure. This is why the positive pole is called the sedative pole by physicians, as the increased production of oxygen lessens the blood supply and tranquilizes irritated nerves.

It determines the direction of the poles in an electro-magnet by the direction the current takes through the windings of the coil. It rotates a magnet with a North pole in its direction.

Negative Phenomena—Where this form of motion leaves a conductor, it decomposes a fluid or semi-fluid medium like animal tissue. Hydrogen gathers around the end of the conductor, and produces an intense alkaline reaction. Many compounds are disintegrated, the acid radi-

cle going to the positive pole, while the alkaline gathers around the negative, so that this pole is called the stimulating pole, owing to the rapid changes that are induced in its vicinity.

Stimulating Pole—We know that animal tissue is very soluble in a strong alkaline medium, and we use this pole to dissolve exudates not well supplied with blood. It acts as a stimulant, owing to the increased blood supply brought to the part to protect the organism from the destructive irritation.

Dynamic Currents—If we take a coil of insulated wire, with the ends disconnected, and raise it from the floor by a dynamometer, and ascertain its weight, and then connect the ends together and suddenly raise it from the floor, we will find that it has apparently increased in weight as it requires more power to move it. This experiment is the base of all magno-electric generation.

If we take a closed coil and revolve this coil by mechanical means, we will develop a current of electricity within it. This is due to the turns of wire cutting the magnetic currents of the earth; if we now enclose our coil of wire in iron poles, surrounded with coils of insulated wire, and connect them in such a way that the currents from the closed coil are obliged to circulate within the wire around the iron, we get the same current as before, but as the current now circulates around the iron within its closed coils, we magnetize the iron, thus strengthening the feeble earth currents, and we get a greater volume in our closed coil that we are rotating. Gradually more power is required to continue the rotation, as the iron becomes more firmly saturated with magnetism, until eventually only a relatively small amount of current is required to keep the iron saturated, and we have a surplus for other purposes.

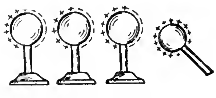
In this class of machinery, the electro-motive force is determined by the number of turns of wire and the speed with which we drive it through the magnetic fields, while the quantity of current is determined by the size of

the wire used and the size of the machine, or rather the amount of iron in the magnet.

We can use the same machine either to develop a current or to absorb a current from some other source, and it will act as a motor. It is turned by power in one way for a dynamo, and it turns in the opposite direction as a motor. By simply changing the armature connections, they can be run in either direction at will.

THE EFFECT OF THE CURRENT UPON THE SURROUNDING MEDIUM.

Induction—If we take a conductor and surround it with other conductors four inches from it, insulated by the atmosphere, we will find when we send a current of one volt through the central conductor in a certain direction that we have a current in the neighboring conductors, but in the opposite direction. This current is instantaneous and only lasts while the first conductor is being charged. If we now break the current suddenly, every one of the conductors within four inches will show an instantaneous current, but in the opposite direction to the first one.



Now, if we increase our current from one to four amperes, and move our conductors to 16 inches, we do not get any effect upon the neighboring wire. If we increase our electro-motive force, however, to four volts and allow the amperes to remain at one as before, the same phenomenon is noticed, and we find that as we increase our electro-motive force, we can increase the distance of our conductors in arithmetical progression, and the disturbance has been detected a distance of two thousand miles from its source.

Hertzian Waves—It is this phenomenon discovered by Faraday and elaborated by Prof. Hertz now called the

Hertzian waves, and which depends upon the electro-motive force alone, and is used in Wireless Telegraphy and Telephony. There is no limit, apparently, to the distance this disturbance can be sent out into space, as the electrician stands ready to supply the apparatus upon demand.

It is observed that we have here a disturbance depending upon the sudden polarization of a conductor, or condenser, that passes out in all directions from the source of disturbance, going to a distance depending upon the electro-motive force of the disturbing agent. It is instantaneous in action, electro-magnetic in quality, and decays in heat when it comes in contact with a suitable conducting medium. It is not influenced in the slightest by the amount of amperage, after we have just enough to charge our condenser or conductor.

It has also been observed that when a current is broken within a conductor, that a certain relief of strain takes place, and a return wave returns to the apparatus, so that we can compare the surrounding ether to a coiled spring, or a state of stress, which rebounds as soon as the strain is removed. This phenomenon is called **induction,** and in its simplest form means a blow or series of blows upon the surrounding medium called the ether. We can have a positive induction, which polarizes the free moving bodies to move suddenly towards the polarized conductor, or negative induction, which repels all free moving bodies of the ether.

Polarization of a Conductor—If we now take a wire and suspend it in iron filings and send a current of one volt and one ampere through it, we will find that a certain amount of the filings adhere to the wire and remain suspended as long as the current is passing. If we increase our electro-motive force, no more filings will adhere, but by increasing our amperage to five amperes, we attract about five times as many iron filings as before, so that it can be seen that this phenomena is associated with the current, and not with the voltage. This is called the **polarization of a conductor,** and shows that every conductor

is surrounded with the magnetic lines of force and holds numerous bodies polarized in its vicinity. This is of importance from a theoretical standpoint, as there are many electricians who are firmly convinced that after a conductor is polarized, that the actual transfer of energy is through the insulation or the ether. There are many facts both for and against this theory, and, for the time being, it must remain under consideration, awaiting further investigation.

The Ether—It is evident that if a disturbance can pass away and back to a conductor, that it must have some medium to travel upon or within. It is known that it does not travel through the atmosphere, to any extent, so that space must be filled with some intangible medium which can carry light, heat, magnetism and chemical wave action, and that it must be of the greatest importance, as it is through this medium that the gigantic forces work, that keep the sidereal universe in motion.

It is impossible for the finite mind of man to go beyond the bounds of our own sidereal system for information, but enough has accumulated to give a fairly intelligent view of this medium, and allow us to understand something of the forces at work in our solar system. We know that our sun is an incandescent ball of gas, inconceivably hot, which is sending out into space a shower of minute, vibrating particles, somewhat like the steam from a kettle. It radiates in all directions, the constant supply being maintained by the intensity of the action going on within the sun. This body is known to fluctuate with enormous tides daily, while it is in constant rotation.

These fluctuations give a variable potential that keeps an electro-magnetic field passing out into space and agitates the electrical charge carried by the corpuscles, each with a negative charge, and compels them to vibrate in harmony with its gigantic parent, so that we can conceive of each one of these bodies with a negative charge, throwing out its lines of force and endeavoring to get as far from its neighbor as possible, creating a negative field or a negative

stress throughout space; now, we know there is nothing in the physical field so sensitive as an electrical stress to the disturbances of other electrical manifestations, and as we know that the earth will absorb both positive and negative electricity, we do not have to use our imagination a great deal to understand what effect a shifting or alternating field would have upon a round ball like the earth, when it passed at right angles to its poles.

Those of use who have watched a copper or aluminum egg roll in step to an alternating or shifting field, can readily grasp how the motion of the earth responds in step to the solar electro-magnetic field, and many facts of the phenomenon of gravity becomes clearer in consequence.

All physicists agree no light can exist in space, and it is only when these vibrating, polarized particles reach our great atmospheric ocean (about 29 miles deep) that their energy is imparted to the atoms and dust particles and the fluorescent effects that the animal eye interprets as light appear. Many physicists claim no light would appear without dust particles.

We are prone to forget that we are poor land-crabs living at the bottom of a vast atmospheric ocean, and securing our light, heat, and magnetism from the distant sun, and are apt to think that the whole scheme of Creation is calculated for our benefit. Still more wonderful have been the discoveries of the geologic survey of the ocean beds to find fish over five miles deep with well developed eyes, with their bodies coated with fluorescent material, and to find the bed of the ocean made up of ooze, which is composed of the bodies of minute shell-bearing animals, very rich in the carbonates and fluorescing under certain radiations, and it excites our wonder when we begin to speculate as to how they secure the necessary light to enable them to have their being, and in order to find the solution of our problem, we must again turn to our sun.

It now is conceded that a great range of vibrations is sent out from the sun, some of which do not reach our

earth, being absorbed by the atmosphere; others as light, heat, chemical action and magnetism, we can detect upon the surface, and a higher amplitude of waves that pass to the bottom of the ocean, while others pass on and through our earth, and out into space again, so that it is possible that owing to the foresight of the Creator the bed of the ocean is no more dismal for its inhabitants than the surface of our earth proves to be for us.

The human mind can scarcely realize the varying conditions under which life can and does exist. We have learned some of the functions of the Ether, and can begin to realize something of its magnitude and value to the universe, and we can now attempt an explanation in order that the reader can get a mental grasp upon this difficult subject.

Ether, Definition of—If we can conceive of a closed space, say a closed vessel containing water, we apply heat and after a certain amount of energy is absorbed, the molecule is disassociated and the atoms polarized with a negative charge. If we use a suitable instrument, as a steam gauge, we find that the more strongly the atoms are polarized, the greater their repulsion, and consequently the greater the pressure. Now, if we have this confined in a suitable vessel so that a part can be pushed in narrowing the confined space, we learn that the pressure rises temporarily and goes back when the space is restored. Now it is evident that each particle is trying to get just as far from its neighbor as the confined space will allow, so that we can imagine them as a small body with lines of force pointing in each direction. If the strain becomes too great, an explosion will take place, while the bodies will escape in all directions, and will travel until their stored energy is lost.

By this analogy we can get a small view of the ether, a field with a negative charge through space, being constantly agitated by the gigantic conflagration going on from our numerous suns and by analogous reasoning, we understand why the planets occupy certain spaces sur-

rounding each local sun by becoming familiar with the so-called nodes of an alternating current field, places in which the waves dampening each other with only a slightly greater polarity in one direction. So that we can regard the ether as a sensitive electric field, its charge being swayed by every change of potential throughout the universe. The amount of displacement depends upon the energy of the exciting force, and it is through this field that we are gradually binding the human race into one great family, and have begun to reach out into space, looking for more of our kind.

The existence of this medium, and its known properties of carrying light and electricity, has always interested the theoretical electricians and physicists, and has given force to the thought, that eventually communications may be established with some other inhabited planet.

ELECTRIC CURRENT IN VACUUM TUBES.

In the year 1806, Michael Faraday, while experimenting with the electric current in the Bell Jar of a vacuum pump, made the discovery that the phenomenon would change under a certain degree of exhaustion from a plain spark to a glow of a purplish color, and if he carried the exhaustion farther, that the color was replaced with a blue one, and that the resistance of the tube decreased—in other words, that a current could travel a greater distance through a tube that was partially exhausted by the pump than it would through the atmosphere.

Improvement in apparatus allowed Prof. Hittorf to carry the exhaustion farther, and he found that the blue color changed to a blue-white and eventually to a green fluorescence. While he antedated other workers, his result was lost to the scientific world for over thirty years, owing to the unfortunate title he chose for his paper, viz., "The Behavior of Electric Current in Gases."

Sir Wm. Crooke startled the scientific world in 1889 with a remarkable paper, claiming the discovery of a new form of matter which he called "radiant." He gave a mas-

terly series of experiments to prove his contentions—the finest the world has ever known—and while he did not succeed in carrying his convictions in the face of the criticisms from his colleagues, he made a most perfect series of experiments to demonstrate his point.

His work is classical and epoch making and as a knowledge of them is so essential to the work of the average physician, a short review will be given, owing to the fact that access to the original papers is impossible to many of our profession.

Prof. Crooke succeeded in improving the mercury pump until he was able to exhaust the tube to a millionth of an atmosphere, and he observed that the phenomenon changed to a green fluorescence, and became interested in what took place within the tube.

The Anode Stream—He found that the Anode stream could be made to follow any given path by constructing the tube in different ways, and could be bent at right angles and be deflected by a magnet.

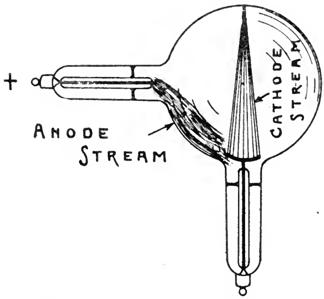


FIG. I. SHOWING DEFLECTION OF ANODE STREAM AND FOCUSING OF CATHODE

The Cathode Stream—The wonders of the vacuum tube are more closely studied in this curious phenomenon. He found that it could not be made to turn corners, but could be deflected by means of a magnet, towards the positive pole, and away from the negative pole, demonstrating that the stream was a negative phenomenon.

He constructed a tube with a rotating vane in the path of the cathode stream, by deflecting the cathode ray by

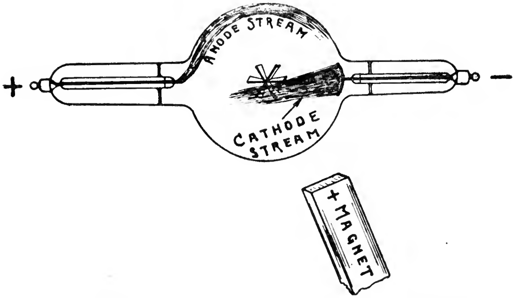


FIG. II. SHOWING ATTRACTION OF CATHODE STREAM BY THE POSITIVE MAGNET

means of a magnet, he caused the vane to rotate in either direction at will, showing that particles of sufficient weight were present, and did carry energy.

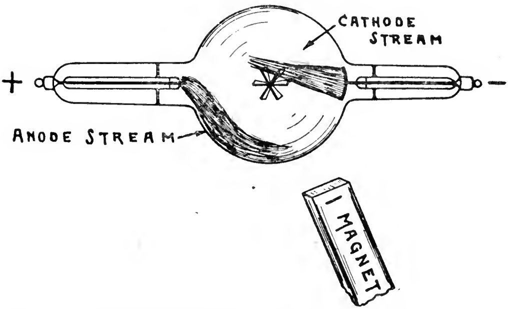


FIG. III. SHOWING DEFLECTION OF CATHODE STREAM BY THE NEGATIVE POLE OF A MAGNET

By curving the cathode, he found it was possible to either bring the ray to a fine focus or disperse it at will upon the glass walls of the tube.

He placed a piece of platinum in the path of the cathode stream, and by curving the electrode brought it to a focus upon the metal and found that it was brought to in-

candescence showing that considerable energy could be carried through the tube, and delivered where required.

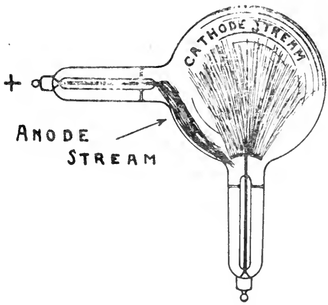


FIG. IV. SHOWING EFFECT OF CURVING THE CATHODE ELECTRODE

He placed a refractory piece of metal with a slit in it in the stream, and another piece back of it with a fluores-

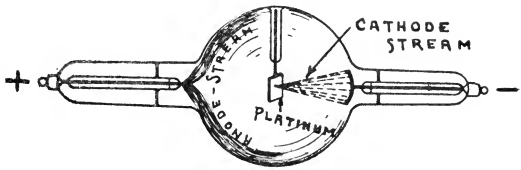


FIG. V. CATHODE RAY BRINGING PLATINUM TO INCANDESCENCE

cent substance, and found that the ray would not pass through thick metal, but caused fluorescence when it was absorbed by a suitable salt.

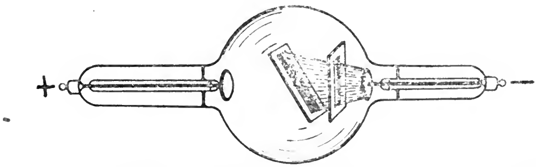


FIG. VI. SHOWING FLUORESCENT EFFECT OF CATHODE STREAM

He constructed a tube with a cathode of tin, which leaves a black deposit upon the walls of the tube, and dem-

onstrated that particles could actually travel through a tube, so that by placing a maltese cross in the path of the ray, an exact stencil was produced upon the walls of the tube.

In order to demonstrate that it was actually solid bodies that passed through the tube, he exhausted a tube to a very high degree, and sealed into it a potash bulb to absorb

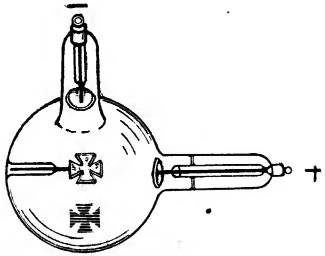


FIG. VII. SHOWING ABSORPTION OF CATHODE RAY BY METAL, AND THE TRANSFER OF PARTICLES THROUGH TUBE

any bodies that were left, and found that it was impossible to force any current through the tube, while by warming the potash bulb, moisture was driven off and the tube could again be used, while they were again absorbed when the tube was at rest, giving us our original high vacuum.

From these experiments, he concluded that matter was present in an extremely divided form, much smaller than the atoms, and he proposed the name of "Radiant" to cover the phenomena noted. He was unsuccessful in maintaining his contentions before the society, the verdict being that he had succeeded only in destroying atoms, and that the bodies present were the "fragments."

In passing, one phase of Hittorf's work deserves attention, as this man amused and instructed himself and others by sealing into the tube numerous kinds of matter, as earths, clays, rocks, precious stones, and found that when any of these substances were placed within the cathode stream, they glowed with a wonderful brilliancy, and of all the colors of the spectrum, depending upon their

composition. Wonderful secrets are still hidden within this mysterious form of motion called the cathode stream.

The Geissler Vacuum—Preceding Crook's work by many years, Geissler had investigated the vacuum below a millionth of an atmosphere, and constructed many wonderful and beautiful creations to instruct and amuse vast audiences with this wonderful phenomenon.

Geissler carried the pumping process far enough to disassociate the molecule and liberated the atoms, and found that he could get a blue or purple fluorescence by the action of the pump, and by driving these polarized atoms along geometrical paths, he produced many beautiful creations. Later, he sealed salts within the tube, and later still, the solutions of salts, and found that each one emitted a light characteristic of the element used.

These tubes were used by our high-priced Professors in our expensive college laboratories for thirty years, before Prof. Hertz took up the problem with an inquiring mind and endeavored to learn more about this phenomenon. He sealed within the tube a piece of aluminum backed with a photographic plate, and found that the cathode ray would pass through thin sheets of this metal and would reduce silver salts. His untimely death alone prevented him from discovering the X-Ray.

His pupil, Paul Lenard. completed his experimental work by sealing into the walls of a tube a thin sheet of aluminum, and brought the cathode ray outside of the tube. Here he could investigate it at his leisure and found that it penetrated black paper, had actinic value, could be deflected by a magnet, had fluorescent properties, and was absorbed about four inches from the tube by the atmosphere.

He sealed opposite the aluminum window a four foot tube, containing a piece of iron coated with a fluorescent salt, and exhausted it to the highest Crooke's vacuum, so that a current of electricity would not pass through the tube, and by moving the coated iron along within the tube by means of a magnet, he found that the cathode ray would

pass to the extreme length of the tube without loss of power, showing that its energy was not absorbed by the ether, and that it was the cathode ray was proven by the way it responded to the magnet.

It was while duplicating these experiments of Lenard that Prof. Roentgen, in Dec. 1895, observed a screen of Barium-Platino cyanide to fluoresce brilliantly several feet from an excited tube, enclosed within a light, tight box. He picked it up, and upon holding it before the tube, observed the bones of his fingers and hand, they being visible at a distance of four feet from the tube. He made the experiment with a photographic plate and obtained a photograph of the bones of his fingers.

He was under the impression that he had discovered a new light, and began and carried out a masterly series of experiments to make the new radiation conform to his conception of known laws of light. In this he was disappointed, after trying many hundreds of prisms of solids, liquids and metals. He was unable to refract it, except a very slight deflection was noted in a prism of aluminum, so slight that the question was left open for other observers. He was unable to polarize it, and had some very curious results in trying to reflect the ray. He placed a number of discs of metal of different atomic weights behind a photographer's plate, and observed their image upon development, very slight in the lighter metals, but well marked in the heavier, and noted the curious fact that the brightness of the metal had nothing to do with the strength of the image upon the plate. In other words, a dull black piece would reflect as much as a polished piece. He was not able to explain this to his own satisfaction, and left the question open for other workers.

THE X-RAY TUBE.

As we have studied the phenomena that take place inside the tube, it now becomes necessary to get a working knowledge of the forces at work out of the tube. We are struck immediately with the fact that there are a number

of different rays given off from a tube in general use, of which we are familiar with only three.

We find that the ordinary tube gives off positively charged particles to a distance varying from one to four inches that are capable of discharging a negative electroscope. The distance they are thrown off depends upon the electro-motive force and the thickness of the walls of the tube. With a powerful static machine they may be thrown to a distance of ten inches owing to the fact that a machine of this type gives a powerful unidirectional current. These rays resemble the cathode rays, as they will pass through aluminum, have powerful photographic properties, cause fluorescence and may be deflected with a magnet. They are very irritating and destructive to organic tissue, having a pronounced inhibiting or destructive effect upon bacteria and are the rays used by operators to treat lupus, and other infectious skin diseases. They are known as the **"Alpha Rays."** Many of the best tubes do not give off any of these rays, and this accounts for many cases of lupus that have failed to react kindly to the ray treatment.

The Beta Ray is a shower of negatively charged particles that will discharge a positive electroscope and are slightly deflected by a powerful magnet. They have intense chemical value; will pass through dense tissue, through different thicknesses of metal according to its atomic weight; cause slight fluorescence; reduce photographic salts, and pass from two to ten feet from the tube. This ray should be considered as the X-ray proper, the ray used in skiagraphy and for radio-therapeutic treatment.

Value of Ray—The value of this ray depends upon the amperage of the apparatus and the penetration upon the electro-motive force. This ray is used to give treatment for large epithelioma; cancers both upon and beneath the surface. Penetration of the ray is controlled by regulating the electro-motive force of the apparatus. It should be the aim of the operator to secure just enough penetration to allow the ray to come at rest in a part of the body where we desire the work to be done.

This ray is not especially irritating and may be used for long periods of time without seriously endangering tissue: although a powerful influence is exerted upon the tissue within which it comes at rest.

It is no uncommon thing for operators while treating the breast for cancer, to produce a severe bronchitis, or even pneumonia if the ray is allowed to reach these tissues, while several cases of meningitis have followed the use of the ray upon the skull.

No operator can hope to be successful until he has mastered the technique of penetration, for the simple reason that the human tissue can act as a conductor of the ray and carry it through without the slightest amount of work. And I cannot impress too strongly upon any physician who uses this method of treatment that to accomplish results in malignant diseases with certainty the ray must be arrested at the place where we want the work to be done.

The Gamma Ray—This ray is an electro-magnetic pulse in the surrounding medium called the ether, the rapidity of the waves depending upon the period of the interrupter used in the coil. Delicate galvano-meters and coherers have detected this ray at a distance of three city blocks and probably the disturbance passes many miles from the source. This ray causes fluorescence when transformed by suitable crystals; has very feeble chemical power; is absolutely non-irritating to human tissue; will pass through an unlimited amount of organic tissue and will pass through five inches of iron. It is the ray we use in fluorescopic work; it has a stimulating and tonic effect upon the body, and the nutritional effect ascribed to X-ray treatment is unquestionably due to this ray.

This ray is used in radio-therapeutic treatment for tuberculosis, sarcoma, and as an inhibitive treatment for hopeless cancer cases. It has a pronounced analgesic quality and will relieve the pain of a severe case of cancer, tic douloureux or rheumatism.

Owing to its stimulating properties a hopeless cancer patient may be made comfortable and life prolonged for from one to two or more years.

For practical purposes this ray is obtained from an old tube that has been so thoroughly plated with ionic metal upon the inside so that very little of the Beta ray can escape. Or, not having a tube of that kind in stock, the rays are passed through a grounded aluminum screen, which sifts out the positive and negative principles and allows the Gamma ray to pass through. The thickness of aluminum used depends upon the condition of the tube and the character of exciting apparatus.

X-RAY TUBES.

Return Ray—Many operators were astonished to find that a radiation returned from space to an active tube, and that it was possible to make a skiagraph, after protecting the plate with a thick lead plate and putting the photographic plate under the lead and between the tube

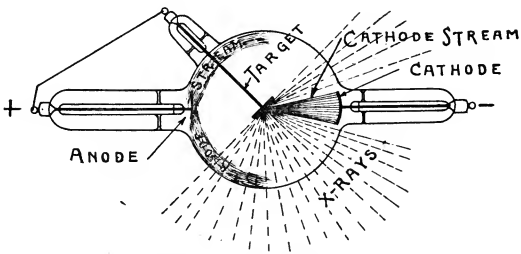


FIG. VIII. SHOWING MECHANISM OF THE DIFFERENT CURRENTS IN A TUBE

and hand. We have found that nearly as good a skiagraph can be made by this method as the regular one, only requiring more exposure.

The Field of Intensity—As the rays travel within the tube with no loss of energy, they meet their first resistance in the glass walls of the tube, and after passing in the atmosphere, they strike the inner

curved surface of the tube at the same velocity, it is clear that their intensity must be in inverse proportion to the square of the distance, so that if we should measure the intensity of the ray opposite the target and four inches from the glass we know that the strength is four times as great at the central point as it can be four inches each side, as the ray has had to travel one inch further in order to reach the surface owing to the convexity of the globe. Therefore, one inch of skin is receiving four times as much ray as the other limit of an eight-inch circle, and if undue exposure is given, we will have a blister formed in the center that will radiate off with diminishing irritation until the limits are reached.

If it is desired to use the Alpha ray it should always be given through a metallic mask and great care used in not over-exposing the surface. Using one milliampere of current at four inches it is dangerous to give more than five minutes daily and even then it is well to skip the fifth and eighth days in order to exclude a possible idiosyncrasy, as it can no longer be denied that there exists a predisposition to a burn from the Alpha ray. This is one of the most terrible accidents that can befall a human being, as it brings about a neuritis with intolerable itching, smarting, pain, and infection can hardly be avoided owing to the patient scratching the place with his fingernails. If this accident happens, the suffering of the patient is terrible, morphine giving little or no relief and the process extends over months or years in certain cases before cicatrization takes place. And if it appears upon the hands they are very apt to be useless. Any irritating application such as vaseline, iodoform, boric acid or any antiseptic will immediately turn an ordinary X-ray dermatitis into a dangerous X-ray burn. The best method of handling the case when it happens is to expose the skin to the atmosphere until vesication takes place, and then dust the surface with common talcum powder (not compound) and nature throws out an adhesive protective coating that

may be removed from time to time by soaking in hot water. It re-forms promptly and protects the surface better than any artificial cover we have.

BELATED BURN.

We may produce a severe X-ray dermatitis from the Beta ray, but it rarely becomes destructive, although cases of belated burns have occurred, one of which is of extreme interest. It happened to a young girl with cancer of the breast who was successfully treated with the X-ray, the cancer disappearing promptly; the girl improved in health and went away on her vacation in June. She returned in September in good health. She called upon me and I examined the breast and failed to discover anything wrong with it. Two weeks afterward she was taken with a stinging, burning pain in the breast and called upon me immediately. I was able to make out a sharp line of demarcation on the site of the former cancer which rapidly became gangrenous. She was put into the hospital and watched a few days until it was evident the trouble was not spreading when I made an incision around in the healthy tissue and removed the mass. I found a cup-shaped piece of fibrous tissue four inches wide in which the pathologists failed to find any bloodvessels. This piece of fibrous tissue was five-eighths of an inch in thickness. This may explain why many X-ray burns are so hard to heal. The wound healed as well as any other wound could and it indicates a successful method of treating X-ray burns by removing the base by surgical methods in order to get a good blood supply.

It seems from a very careful investigation that all of the serious burns in the last four years had been received from the use of static machines. Not that an increase of amperage is derived from this type, but because this class of machines gives an unidirectional current, throwing the Alpha ray to a greater distance from the tube. And also the fact that they are not as well controlled as a coil: and further that they vary from day to day, depending

upon the amount of vapor held in suspension within the case as well as the temperature of the air. The output may vary as much as 50 per cent at different periods of the day. This must be kept well in mind by operators so that they may keep upon the right side of the danger line.

TUBE REGULATORS.

We have learned elsewhere that the resistance of an X-ray tube is disturbed by the current passing through it; that combinations take place between the corpuscles and the metallic atoms that are thrown off the electrodes; that frequently the tube is lowered in resistance by gas driven off from the target by heat, and the resistance raised by the metallic atoms in the same manner.

We have learned that the electrode which suffers the most is the cathode, and it is for this reason that it is constructed of aluminum, which does not leave a visible deposit, and is of a light atomic weight, and as a general rule, it requires some time to seriously affect the proper working of a tube under these conditions.

Offending Tube—If we are using a coil that gives an inverse current, we will destroy a fine tube in a short time, owing to the fact that the short intervals of reverse current tear off the atomic platinum, and deposit it upon the walls of the glass tube. This absorbs the corpuscles rapidly, and we bring about a condition where our tube becomes a chronic offender, the resistance running up rapidly and without warning, while the layer of platinum becomes so thick that it is only with difficulty the ray can pass out of the tube.

To avoid these conditions, we must purchase an apparatus which does not give an inverse current, and must use some device to restore to the tube a fresh supply of corpuscles as they are exhausted.

Regulators—Many principles of physics have been used to accomplish this work, and it is well that we learn something about the fundamental principles at work in this type of apparatus. The function of all of them is to

provide for either a temporary or permanent supply of corpuscles as may be needed.

The Potash Bulb—Sir Wm. Crooke discovered the fact that potash would absorb these bodies within a tube, and also that it would give them out by applying heat, and numerous attempts have been made to utilize the principle in the practical operation of an X-ray tube. The main objection was the liability of cracking the glass with the flame necessary to make the potash part with its moisture, and also to regulate the exact amount of gas to be given off at each operation. This procedure has been adapted and worked out successfully, as will appear later. A very slight amount of heat generally gave a great amount of gas, and endangered the vacuum of the tube so that other attempts were made to find a salt that would overcome the difficulty.

Calcium Chloride with Copper Sulphate—A regulator was devised, using this salt in a mixture, the gas being driven off by means of the current. It was very active and required a very well controlled apparatus to prevent destroying the tube, from the great quantities of gas given off from the substances.

Absorption of Gas—Asbestos, coke, mica, etc., will all give off gas when connected to the negative pole, and absorb it when connected with the positive pole, and some form or modification of these substances are now used in our most successful tubes.

Palladium Wire—The curious discovery was made that this metal contained much air between its atoms, and that it could be driven along the wire by applying heat and that the metal would again absorb more air when it cooled. This curious property has been used to introduce air within a tube. A wire tube is let into the bulb and about three inches allowed to project outside. By heating the end carefully with an alcohol lamp, it becomes red hot. This causes the retained gas to move along between the atoms and escape within the tube, thus lowering its resistance.

Many operators have defeated their purpose by using a match to apply the necessary heat, with the result that a layer of carbon is deposited over the wire and prevents it from absorbing gas. An effort to keep the wire clean is essential, and care must be used not to heat it too hot, or it will melt. One serious drawback has happened where operators failed to cap the wire, as the pressure of the atmosphere has been known to force enough air through the wire to destroy the vacuum—an accident that usually occurs to new tubes, and causes much vexation in consequence.

Valve Regulators—Numerous attempts have been made to construct a tube with a metalic valve regulator, and with more or less success. The main objection is the clumsiness of the contrivance, as attached to the ordinary

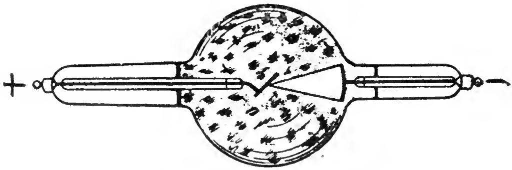


FIG. IX. No. 1 BENOIST SCALE

tube of commerce. They are constructed in such a way that a rotating cylinder containing a minute pocket for air is turned in such a way as to carry a fraction of a drop of air within the tube by a revolution of the cock. They are wonderfully successful, as far as their regulating quantities are concerned, but as yet no mechanic has ever been able to make them small enough to not be in the way of holding the tube in a holder, to say nothing of the practical difficulties of actually sealing it into the tube. It takes no imagination to see that with our modern precision machinery, that these regulators could be made small enough, and with a degree of accuracy necessary to work them properly, if required.

Baking a Tube—Occasionally, we have a fine tube which may or may not contain a regulator that gets so

high in resistance that the current supply will not go through it, and we find we must resort to the Baking process in order to break up the combination of corpuscles that have formed upon the walls of a tube.

We take the tube and wrap it in "Fire Felt," a flexible asbestos cloth, and place in an ordinary gas oven. Light the burners, and turn very low in order to heat the tube gradually—as a general rule about 20 minutes, when we start with a cold oven, is required the first time, and we

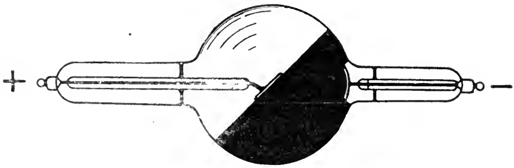


FIG. X. No. 2 BENOIST SCALE

gain a temperature of about 300 degrees Fahrenheit. The fire is turned out and the tube allowed to cool slowly without opening the oven, to anneal it thoroughly, otherwise it becomes very brittle.

When the oven is thoroughly cooled, open and remove the tube carefully, and place upon the machine, and we will generally find that the resistance is below the Crooke's vacuum, and in order to get a high electro-motive force, we must use large spark gaps in the line. The tube must be carefully worked until it is well above the line, and gives off X-rays, when in series with the machine. This procedure may be repeated if thought desirable, several times, but eventually the tube will not respond, and must be repumped to regain its usefulness.

Regulation by Heat—To a lesser degree, the vacuum may be regulated by passing a large alcohol lamp under the tube when in operation. This will reduce it greatly, and if done quickly, will not injure the tube.

All of these devices are defective, because there is no assurance as to just what reduction will be obtained in a

given case, so that each exposure of the X-ray must necessarily differ from the preceding.

Use of Shunt Circuits—Various attempts to overcome this defect have been made, and the most successful is by means of an adjustable shunt circuit so that the current will take the bye-pass, if the tube becomes too high, and cause the regulator to give off more gas. This, in a rough way, maintains the penetration about equal throughout an exposure, as well as between treatments. It is far from an ideal system, but is the best we have at the present time.

Automatic Regulation—The Sayen or Queen tube, as the firm prefers to have it called. This is the nearest approach to perfection of any we have.

The Sayen or Queen tube has an ideal regulator in principle, but the manufacturers have neglected to keep their tube in pace with the generating apparatus, but to-

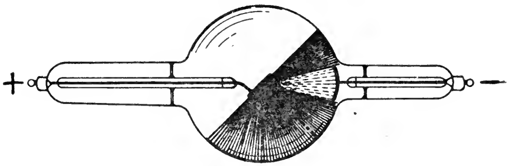


FIG. XI. No. 3 BENOIST SCALE

day it is probably the ideal tube for radiotherapeutic purposes when used with small coils.

This regulator consists of an axillary tube, exhausted to a very low Crooke's vacuum, attached to the large tube. The tube is a perfect X-ray tube, and has its cathode terminal prolonged into an adjustable shunt; which introduces a variable air resistance between the cathode of the small tube, and the cathode of the large one. The position occupied by this shunt will determine the resistance of the large tube when in action.

When this tube is brought into action for the time being the current will pass through the small tube, and jump over the adjustable shunt because the resistance of the

small tube plus the variable resistance of the air gap of the shunt is always less than the resistance of the large tube, which is pumped to the highest Crooke's vacuum, before the tube is sealed. The large tube contains a bulb with caustic potash, which absorbs the hydrogen corpuscles that remain in the tube, bringing about nearly an absolute vacuum when the tube is not in use. The cathode ray of the small tube is brought to a fine focus upon the small target, which is supported by a platinum wire that is prolonged into the large tube through the glass, and termintes into a bulb of caustic potash.

Theory of Operation—The platinum wire conveys the heat from the small target to the potash, and drives off

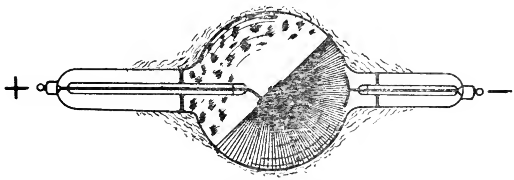


FIG. XII. No. 4 BENOIST SCALE

the moisture it contains, which lowers the vacuum of the large tube, to that of the low small tube plus the size of the shunt; when the current takes the large tube instead of the by path, a spark passes from time to time as the corpuscles are consumed in the large tube, through the small tube which drives off more moisture as required, in order to keep the resistance of the large less than the small one with its shunt.

Variation of Vacuum—If we vary the shunt we are able to vary the vacuum of the large tube at will. The closer the shunt wire is to the cathode of the large tube the lower the resistance of the large tube will be, and conversely the greater the air resistance between the shunt wire and the cathode of the large tube, the higher the vacuum will be. Several serious defects in practice have developed. First, care must be observed not to have the

shunt wire closer than one inch from the large cathode, or the tube will become a jet black from the combinations formed in the presence of platinum, hydrogen, and oxygen, together with the ionic metal thrown off by the electrodes.

Radiation of Heat—The radiating system in this tube is defective, and the anodel target becomes too hot, when used upon a large coil, and more of the energy of the current is transformed into heat, than X-radiance.

Accidents from Explosion—The former high vacuum of the large tube is restored after the tube cools, because the caustic potash absorbs the free corpuscles of oxygen and hydrogen that have been driven into the tube, by the regulation, and it may be used again at any degree of exhaustion as may be desired; several accidents have occurred with this type of tube, apparently the corpuscles have been driven off in about the right proportion to form an explosive mixture, and the tube has exploded with

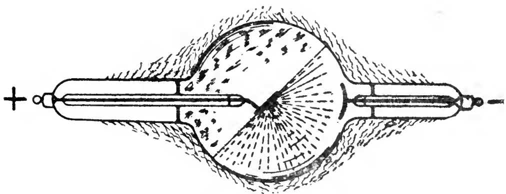


FIG. XIII. No. 5 BENOIST SCALE

great violence, fortunately with no damage to human life; but it is well to protect both the patient and the operator as a serious accident might occur. Oxygen in a tube is very objectionable, as it is likely to unite with explosive violence with the hydrogen, and promotes the transformation of the current from X-radiance to heat.

There are many regulators depending on a shunt circuit, not connected with the tube, but having a wire attached to some chemical regulator that has been let into the tube. Some of them give a fair degree of satisfaction,

but the main difficulty is caused by the regulator either working too much, or taking too much time to restore the tube to its initial high vacuum, before it can be used again.

AUTOMATIC REGULATORS.

Mr. D. McFarlan Moore, in Volume XXVI, No. 4, of the proceedings of the American Institute of Electrical Engineers on Light from Gaseous Conductors within glass tubes, calls attention to vacuum deterioration and says that up-to-date there are four methods of replenishing the gas, and overcoming the difficulty of a gaseous conductor becoming non-conducting, due to the peculiar chemical

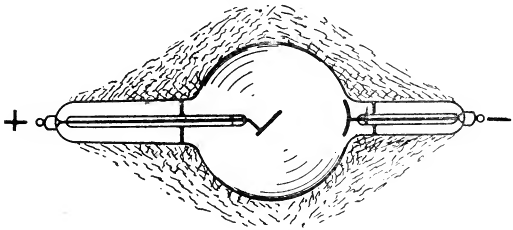


FIG. XIV. No. 6 BENOIST SCALE

reaction that occurs when a current passes from a solid conductor to a gaseous one. He refers to the following methods:

1. A cycle of events brought about by catalytic Action.
2. By evaporation or condensation, mercury being the only element that can be used in this way.
3. Supplying gases automatically by heat on suitable substances.
4. Feeding air through an automatic valve, a so-called "feeder valve."

He describes the valve as follows: "A piece of 7/8-inch glass tubing is supported vertically and its lower end is contracted to a 3/8-inch glass tube, which extends into the

main tube, at the point of contraction, the tube being closed by a ¼-inch carbon plug, fixed by cement."

The porosity of carbon is not sufficient to allow mercury to percolate through it, but will permit gas easily to pass, since there is the vacuum of the tube on one side and the atmospheric pressure upon the other. This carbon plug is normally completely covered with a thimbleful of mercury, which seals the pores of the carbon.

The level of the mercury in the tube can be altered by means of a movable plunger. When the plunger is withdrawn, the mercury sinks, exposing the top of the carbon plug and allowing a small quantity of air to pass through it into the focus tube. When the plunger sinks, the mercury level rises again and reseals the tube.

Plunger Construction—The plunger, a glass tube containing in its upper end a bundle of soft iron wire, is actuated by a solenoid, which surrounds the main tube. The solenoid, in its turn, is fed by a primary current of the transformers.

It may easily be shown that there is a certain degree of vacuum at which the conductivity of the vacuum tube is at its maximum. If, therefore, a tube be used with a vacuum below this point, any reduction in the amount of vacuum will diminish the resistance of the tube. The consequent increase of current through the tube will react on the primary current, causing that also to increase. When such a discharge tube is in use, the vacuum rises, the secondary current increases (in voltage), reacting upon the primary current, and the solenoid is energized more powerfully the plunger is raised, and the mercury sinks.

The air penetrates through the carbon into the tube, when sufficient air has been admitted, the secondary decreases (in voltage), the primary current is weakened, the solenoid loses its pull, the plunger falls, the mercury rises, and the tube is resealed.

This feeder valve can be adjusted to maintain any desired degree of vacuum, by altering the relative position of the solenoid and the plunger. The action of the

valve is quite automatic. The recurring rise and fall of the mercury, exposing the carbon plug, reminds one of a mud turtle taking a breath of air in a mill pond—as others have expressed it, the apparatus actually breathes. When the tube is not in use, there is no leakage of air or other gas through the carbon. It will therefore last for an indefinite time. The vacuum can be maintained within .01 M. M. of the required value.

In skiagraphy, the vacuum must be kept above the point of maximum conductivity, and it might be necessary to use light floating plungers, held down by the solenoid instead of lifted by it. In this case, it would be necessary to use some form of permanent magnet to keep the tube sealed when not in use."

It is doubtful if the primary current could be used for this purpose on an X-ray tube, for fear of a ground taking place and burning out the apparatus. A valve constructed on this principle, to be worked by hand-power using a permanent magnet when the tube required adjusting, would be ideal and could be cheaply constructed.

NOTE.

Corpuscles—This term has been loosely used by writers, and is not generally understood. We have learned they are the bodies that form the atom, and should be regarded as a noun.

Electrons—This word is used many times as a synonym for the corpuscle, but it should be used to designate a corpuscle with an electrical charge, as an adjective.

Ion means a charged body in motion, or rather the term should be defined in this way.

Anion—An ion carrying a negative charge towards the anode or positive pole.

Cathone—An ion carrying a positive charge towards the cathode or negative pole.

MEASUREMENT OF THE QUANTITY OF THE RAYS.

The greatest need felt by all operators has been some simple and reliable method of measuring both the quality and the quantity of the X-ray, and perhaps more ingenuity has been expended upon this problem than all other things combined.

There are two things that strike the amateur operator quite forcibly after a short acquaintance with this method of treatment, and set him to wondering how he is going to get a good mental grasp upon the various techniques given out from time to time by the various laboratories.

A short acquaintance with the ray shows us that we have two important factors to deal with in the X-ray, one of intensity, or its ability to penetrate various forms of matter, and its quantity, or its value, in chemical units.

From the very nature of the case, the problem has been a serious one, owing to the great number of tubes, coils, static machines, interrupters, etc., that go to make up the equipment of the various men engaged in this kind of work, and so many systems have been devised by the different operators throughout the world, that if given in detail they would make, in themselves, a good-sized book.

I shall not attempt to give more than a working knowledge of the most important means of getting at this problem, and for those who are more profoundly interested in the subject, I must refer them to works upon the subject, more historical than I am going to make this one.

Of the numerous methods developed, the principal have been as follows: Measurements of the ray by observation of their fluorescence, by their phosphorescence, their effect upon photographic emulsions, their dehydrating action upon certain salts, ionization of the air, thermal action, and their Photo-Electic action upon sensitive galvanometers.

We have been able to throw light upon the problem by using indirect means, by measuring the current passing

through the primary or secondary coil, the time the current is passing through a tube, by measuring the energy of the cathode stream, etc.

Roentgen drew attention in his second paper to the fact that fluorescence bore a definite relation to the quality of the X-ray. He attempted to devise a method by which he could measure the difference between two focus tubes by constructing a prism of lead, and coating their angles with a fluorescent salt, and endeavored to establish a relationship between the two tubes by moving one farther away until the illumination was equal. Various operators have tried to make this method practical, as Roiti in 1896 attempted to use a glow lamp with a cobalt shade as a standard to compare the Roentgen fluorescence. Later on, acetylene lamps were used for the same purpose by Contremoulins, and Radium Radiations by Courtede. These methods are open to grave error, owing to the defective human vision.

The method of Graiffe depends upon the dehydration of a Barium-Platinum Cyanide screen under the influence of X-Radiation, and is not reliable owing to the different percentages of moisture under atmospheric conditions. Many substances absorb energy and give a phosphorescence under the X-ray, and Prof. Mortheim Salmonson has attempted to use this property by using a film of Balmane's Luminous paint. This substance, if kept in a cool dark room until no trace of phosphorescence is visible, is excited by the X-ray and gives off a bright phosphorescence, and can be compared by means of a ground glass screen of cobalt glass with a standard lamp. The method has not been found reliable, owing to the personal equation and that the results are affected by atmospheric conditions.

To measure the quantity of the Ray, we must depend upon photographic means, and even then several sources of error are present. Numerous attempts have been made by many operators to find some salt that would absorb the Roentgen Ray, and undergo a change of color. Holz-

knecht attempted to solve the problem by using a pastel of soda sulphite, containing a small quantity of meta-bisulphate of potassium, glued together with copal varnish. This combination undergoes a gradual change in color under X-Radiation, and an arbitrary scale of colors were worked out to compare the pastel with. It seemed for a time that the problem was solved, but eventually it was found that their keeping qualities were poor, and that moreover no two persons have an acute vision enough to compare the shades accurately, as they were influenced by the character of light, by which the examinations were made. They even misled their inventor and caused an expensive verdict to be recorded against him for burning a patient.

The Barium-Platino-Cyanide Screen was used by Sabour and Noire. They made pastels of this salt, which is dehydrated under the influence of the X-ray, and changes from a greenish color to a yellow, and later a brown. They are so sensitive to atmospheric conditions, however, that in many parts of the world, their use is out of the question.

Schnartey gets his measurement by precipitating calomel from a solution of Bichloride of mercury and oxalate of ammonium. This is collected by a centrifuge and weighed. This is a fairly reliable method, but is open to the objection that it takes much time, and is modified by the degree of penetration of the Ray.

Freund's Method consists of the decomposition of an iodoform solution in Chloroform. This is reduced in an ionized field and Iodine is liberated and an estimation is made of the iodine set free. The serious drawback to this method is the fact that decomposition is also brought about by light ionization.

Perhaps the simplest way to measure the quantity of an X-ray field is to measure the ionization of the atmosphere. It has been experimentally determined that the X-ray renders the atmosphere a conductor, and an electroscope will discharge itself so that we can measure ac-

curately the quantity of the rays by causing them to discharge an electroscope of known capacity. The time in seconds required to do this, gives us the ratio of the value of the ionized air. It goes without saying that this method is of little use to the average physician, owing to the high cost of a sensitive electroscope, and a mirror galvanometer. Unfortunately, however, it has been found that it is not a reliable indication when the tube does not remain at a given vacuum. The Photo-electric method is a laboratory curiosity and is of such limited usefulness that few operators have either the time or apparatus to carry out the experiments.

Foster discovered that the selenium cell responded to the Radiation by varying its resistance, and Ruhmer, Levy, and Johnson have devised apparatus to measure the ray by utilizing either a screen of Barium-Platino cyanide, or a Tungstate of calcium. The screen is used to transform the radiations, and the resistance is measured by the value of the current passing through the cell, by connecting the terminal to a Wheatstone bridge. It is of doubtful utility, and requires apparatus and knowledge not in the possession of the average operator.

Dorn, Cluny, Rutherford, and Schaefer have attempted to measure the total energy of the X-ray field by causing the absorption of the secondary current and measuring the heat units.

Milliampere Meter—This is the only practical method we have today of forming a fair idea of the output of a tube. We know that the quantity of X-ray is directly proportional to the strength of the secondary current, and while wide variations are possible in the readings, owing to the variations in frequency of our commercial interrupters. Still, it can be standardized for each type, and will give accurate readings within certain limits. It is an accurate indication of the active production of rays, and if allowances are made for the variations in frequency of the interrupters, the thickness of the walls of the tube, as well as its age, we have a system that gives us in prac-

tice the only way we can form a clear conception of the tube's output.

By using this instrument with our installation, we can soon standardize our exposures in such a way that it gives us a guiding hand in comparing exposures with each other.

FIG. XVII. INTRAGRATING MILLIAMPERE METER

If possible, an Intragrating milliampere meter should be purchased, as by this instrument we are enabled to detect any inverse current that goes through our tubes. This instrument hits the high places on the frequencies and gives us a steady reading.

The Hot Wire Milliampere Meter—The operation of this instrument depends upon the heating effects on an extremely fine platinum wire. The expansion and contraction causes a hand to move over a scale, indicating the number of milliamperes going through the tube.

It is only within the last year that Mr. J. B. Wantz, electrical engineer of the Victor Electric Co., has taken up the problem in serious earnest, and from the work so far accomplished, the profession will soon have a low reading hot wire instrument especially calculated for X-ray work.

There is only one serious drawback to these instruments. They do not indicate any inverse current through the tube, but add the total of them to the meter readings.

Gehrke brought out an instrument called the **oscillograph,** which is a slightly exhausted tube, and by watching the variations in the cathode ray, either directly or by means of a rotating mirror, a fair idea of the intensity of the ray may be obtained. If we have the frequency of

the current, the height of the negative light in the instrument, and the milliamperes going through the secondary, we can calculate the value of the ray with only a slight error.

Klingelfus and **Curchod** have attempted to solve the problem by constructing a special intragrating volt meter. This gives no indication of the actual value of the ray from a chemical standpoint, but does give a good indication of the penetration of the ray.

Dean, of London, attempted to solve the problem by constructing a special interrupter, which was automatically cut off after a certain number of frequencies. This method has been brought forward by several different men in different countries, but is open to question, as there is no way to estimate the actual value of the secondary current going through the tube.

Walter attempted to measure the energy of the cathode ray, by measuring the temperature of the target. This is only availaable where the water cooled tubes are used, and is not accurate, owing to the variations in the amount of water in the tube, and the fact that inverse current frequently is transformed into heat in the target. The time of exposure and the original temperature of the water in the tube.

Jiraka attempted to express the value by, as the time and voltage in the primary and the milliamperes in the secondary, reducing the time to Watt seconds, and called his unit the Vlasts, which is the number of watt seconds of the secondary divided by the ratio of the primary circuit. It is open to serious objection, owing to the coil losses in the different construction, and they vary all the way from 15 to 60 per cent in the different types of apparatus.

Many operators have attempted to estimate the Ray by measuring the watts absorbed by the primary of the coil, and its frequency. This, of all the methods, is crude, owing to the construction of the various types of coils, as many of them will give the same output on three am-

peres as others will upon twenty. On the whole, the only method we have in which we can make an approximate estimate of the value of the ray is the Intragrating milliampere meter, calibrated and constructed for low reading, and dividing our treatments into milliampere minutes. This has been used by the Author for eight years with perfect satisfaction. The only source of error is its adaptation to each type of apparatus: the operator must develop his own technique. If a standard number of frequencies were adapted, and the tubes did not vary much in thickness, no error would be present.

Measurements of Penetration—To distinguish the difference from quantity, we must not confound it with intensity or penetration, as the latter is the ability of the ray to overcome resistance, as will be seen elsewhere in this volume, the penetration depends upon the electromotive force, while the quantity depends upon the milliamperes, so that a good method of estimating the penetration is the Author's method of taking the voltage by means of a milli-voltmeter, and multiplying the millivolts with the milliamperes we get the actual number of milli-watts, and by using the time constant, have no difficulty in getting an accurate view of what energy the tube has given off in a given length of time. As the manufacturers have as yet not catered to this demand, apparatus for this work is difficult to obtain, and must be made by the operator, so that other methods which depend upon the ability of the ray to penetrate certain metals or other forms of matter have been used.

Roentgen constructed an aluminum-platinum window by which he was enabled to place different thicknesses of aluminum in the path of the ray, and was able to estimate the penetration approximately by the amount of aluminum it would penetrate.

This has been modified by many operators, some using one metal, and some another, but all depending upon this principle. Carpenter mounted an oxtail in a block of hard wood, after hardening in formalin, and backed the combi-

nation with a screen, but this has the disadvantage, as has all methods of penetration depending upon the screen of taking the operator in the active field of rays—a place he does not belong, and should never go.

Of the great number that have been put on the market, Benoist's is the best constructed, and most practicable of penetrameters. He used a central silver plate 1 M. M. thick, and a number of leaves of aluminum are rotated before a window until enough are before it to absorb the same light as the silver layer. These layers are 1 M. M. thick, and are numbered according to a scale. This method is probably the most popular one we have, judging by the number of operators who use it in practice, and in no small way may have contributed to the condition of many of the operator's hands from chronic X-ray burns.

Numerous attempts have been made to approximate the penetration by the parallel spark gaps, but some investigations made in late years have gone to show that it is no indication of the actual penetration, owing to the variation in the construction of the tubes, and the amount of ionization of the air from a large transformer.

I have tried nearly all of these methods and have found that they all have more or less serious drawbacks, and I still think that my method is the most practical, even if it does involve the use of instruments high in price, and liable to get out of order, by accidental means. The actual watt value of the secondary current, the time and frequency being known, exposures can be duplicated readily enough for all practical purposes. Considerable experimental work has been done during the last year to develop a low reading high resistance watt meter for use in this work: as yet the solution seems far in the future, not that one cannot be constructed, but to get one that will not be liable to break down upon heavy usage.

Kienboch's method has been adopted by a great number of laboratories, and great efforts have been made to have all of them use it in their literature, but the amount of detail work necessary to carry it out perfectly has de-

terred many from using it. He substituted a photographic paper from the plate, and by developing this with a certain formula for a certain time. It is compared with an arbitrary scale of exposures: it is called the Quantimeter. He exposes a number of slips of sensitized paper and develops them one after another, until he obtains the proper shade, when the exposure is stopped. This method, while it is very accurate, when conscientiously carried out, is too troublesome for the American physician. He simply won't use it; it is too much work.

It has been called to my attention during the last year that Dr. J. Bergonie has been using a method of measurement similar to mine, by using an electro-static volt meter to measure the penetration of the tube, and he states that by using the volt meter with a milliampere meter, that the amount of work done in the tube can be accurately measured. He compared his volt meter method with the Benoist scale and made the following interesting observations (see paper, comptes Rendus, de l'Academie des Sciences) Jan. 7, '07, that

12000	volts	equaled	2°	Benoist	Scale.
20000	"	"	3°	"	"
25000	"	"	4°	"	"
30000	"	"	5°	"	"
35000	"	"	6°	"	"
42000	"	"	7°	"	"

With the same voltage, the penetration was the same, even if the milliamperage should vary. No variation was found with the various makes of focus tubes, the readings being practically the same.

Numerous attempts have been made to construct a watt meter for this purpose, and with enough successs to justify the expectation, that eventually a practical form will be devised. This would simplify Radiotherapy so that a few changes in our coils, taking taps off a closed transformer, in order to get the desired voltage, all that would be necessary would be to reduce a tube enough in re-

sistance to run on the prescribed voltage and give so many milli-watt units as a treatment.

IONIZATION OF THE ATMOSPHERE.

Few operators realize the importance of this physical phenomenon to their work, and it is questionable if a true realization of the immense importance this condition has upon the production of the X-ray.

When a beam of light is allowed to project itself through a darkened room, a condition of the atmosphere is brought about that will allow it to conduct a current of electricity along the path of light. A charged electroscope will discharge itself along this beam in a time calculated by the square of the intensity of the pencil of light, and inversely proportioned to the amount of its charge. We can understand readily enough why this is so, when we realize that light itself is an alternating current of a very high frequency and one of the best known laws of electricity teaches us that a path for a low potential current can be made by the passing of a high potential during a small fraction of a second.

This principle, while well known in light, has never before been investigated from the standpoint of the radiographer, in order to ascertain, what effect a beam of light would have upon the production of the X-ray, as we know that this radiation is electrical in character.

A long series of exposures were made with the milliamperemeter and voltmeter in the secondary, in order to give the same amount of energy at each exposure. The photographic plate was covered with the usual envelopes, and several wedge-shaped pieces of different materials, as fibre, fluids, with salts in solution, and of aluminum. These wedges were made on a 23° angle.

The normal exposure was made in total darkness, with even the tube covered with black velvet to exclude all light from the room, and a standard of five seconds' exposure was adopted, with three milliamperes at 30,000 volts, giving a penetration of No. 5 upon the Benoist scale. Several exposures were made and developed from

a fresh solution of developer, for a certain length of time, and the plate fixed, a new portion of the developer being used for each plate, and the temperature regulated at 60° Fahr.

By removing the covering from the tube, so its light escaped in the room, we found it required 10 seconds to get the same reduction of silver as before. A powerful beam of light from an iron electrode light, which was grounded after passing through the active field of the tube by shining upon a water pipe, required an exposure of 30 seconds to reduce the same amount of silver. Diffused daylight required 20 seconds' exposure, while a beam from the noonday sun, reflected by means of a mirror through the field and allowed to strike a grounded screen, required 180 seconds to reduce sufficient silver to compare with the original plates.

These experiments were repeated several times in order to eliminate errors, and verify our standards, and thy came close enough to determine the general law that the strength of the X-ray is varied in inverse proportion to the amount of ionization of the atmosphere after leaving a tube.

This discovery will be of far-reaching importance, and will explain many of the seeming inconsistencies of radiographic exposures, and presents a method of making radiographs with a minimum of exposure.

The ionization of the atmosphere allows the highly polarized X-ray an opportunity to escape. Its charge is neutralized and diverted from its course, and its energy absorbed by the surrounding atmosphere.

A strong beam of sunlight was allowed to pass through a pin-hole, making a narrow pencil of light pass through the active field of an X-ray tube in action, and a normal exposure given in order to see if any effect would be produced upon the plate. Its outlines were very strongly marked, and showed that the energy of the ray was absorbed by the light that passed through the field.

This discovery introduces a new factor in radiography, and may explain the efficiency of some of the different types of apparatus as used by different operators.

It seems clear from the foregoing that physicians must do their X-ray work in a darkroom, or at least one where the general intensity of light remains about the same.

There are many other unknown factors in the X-ray that will repay study, and when they are learned, it may be possible to devise a technique that may be used universally, with all types of apparatus.

No greater mistake can be made by any physician than to delude himself that he knows all about this radiation and attempt to despise it as a harmless agent. I have learned after twelve years' daily association with it that we know very little about it, and that it conceals a world of possibilities that are so far hidden from our knowledge. Its marvelous effects upon individual cases of disease, its utter lack of effect upon apparently similar cases, cannot be explained upon any other grounds than ignorance of the operator. He is successful because of things he does not understand, and fails in his work for the same reason.

GENERATORS.

To obtain a high potential current for X-ray work, we must have some form of generator, especially calculated for this purpose, and we have found that the work can be done in many ways, and we must classify them as follows:

Open Transformer or X-ray Coil.
Closed Transformer.
Special High Frequency.
Static Machines.
Storage Batteries.

The Open Transformer has been the instrument used in most laboratories up to the present time, and may be preferred for some time in the future, although the progresss now being made with the closed transformers and the High Frequency may at any time supplant them. As

a general rule, the principles of the Ruhmkorff coils are followed with some modifications of the Richie system of winding. Ruhmkorff wound the secondaries of his coils straight across from one side to the other, running the wire through shellac as an insulating medium. This was found to be a fatal weakness when we began to use them for high potential work, owing to the amount of moisture retained by the alcohol in the shellac. No method could prevent both moisture and oil being included in construction, so that in order to keep the insulating properties within reasonable limits, the bobbin system of winding devised by Richie has superseded the old methods.

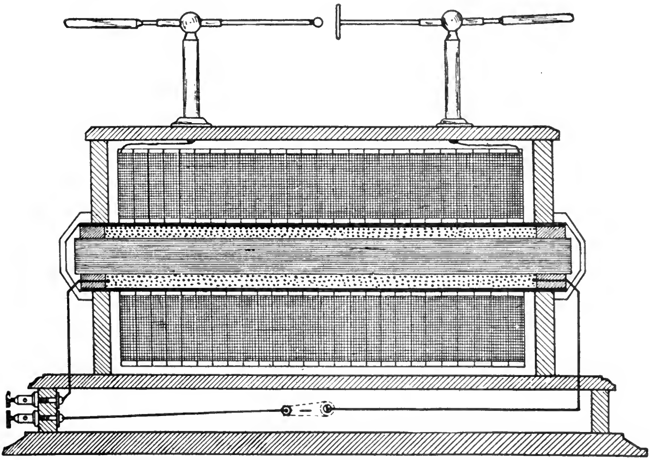


FIG. XV. OPEN TRANSFORMER OR SO-CALLED X-RAY COIL

The Open Transformer is constructed by taking a given quantity of soft annealed iron wire of a known quality, and by compressing it into a bundle, from one to three turns of insulated wire is wound around the iron and connected either in series or parallel, or in certain coils so it can be used both ways, if desired. This is called the **Core or primary** of the coil.

The Core—We use wire of from No. 8 to No. 14 B. & S. gauge for our primary windings, depending upon the construction of our coil and the output desired. During the last few years, the primary has been constructed in such a manner that a tap has been taken off at regular places in the primary windings in order to vary the **inductance** of the coil. In this manner, we can get just enough electro-motive force to excite any tube we desire, and work it at its maximum capacity, without getting a superfluous amount of voltage as a disturbing factor. This is an ideal manner of construction, but probably few operators have discovered its desirable qualities as yet, owing to a general lack of knowledge upon this subject, and the farther fact that the majority of X-ray men will persist in using too high a tube.

Penetration and Inductance—If we learn just what penetration we get upon a certain button of our primary coil, all we have to do to obtain this penetration is to connect up our coil this way, and reduce our tube to the desired vacuum, and in this way we eliminate the matter of guesswork, and work with precision. By this method, if our tube goes to a higher resistance, it simply will not give off X-rays with this voltage until it is reduced again.

Shunt Circuit—For those operators who use a shunt circuit tube with a regulator, it can be maintained at this resistance, with no trouble, for hours. By doing away with our extra voltage, our tube balances well, and no flickering is noticed in its operation: moreover, we can crowd a tremendous amount of current through it without much surface induction.

Insulation of Core—After a primary is wound, it is boiled in either a wax or insulating compound, in order to prevent the possibility of an arc forming between the layers. For a standard 12-inch coil the size of the finished primary is 2⅞ inches in diameter.

We wind our secondary in bobbin form, and in several different systems. The so-called "pancake section" effected by the manufacturers of wax coils, and the bobbin

section—usually one inch wide—as used by those manufacturers who use soft insulation, as vaseline. These bobbins or spools, after being wound, are saturated with an insulating compound and assembled in a suitable box, and upon a tube of mica and shellac, after the coil is put together, with all joints soldered, the box is filled with wax or vaseline, as may be preferred, and the primary placed into the tube. It is made in this manner to permit its removal for repairs if found necessary from accident.

Skiagraphic Coil—For skiagraphic work, a 12-inch coil is amply sufficient for all practical purposes, and if properly made, will make a plate in as short a time as the larger ones.

A well made coil wound in pancake sections, and insulated in Beeswax is in every way the best coil, as it is almost unknown for one of them to break down under strain, while the winding being almost solid wire with only a thin layer of cellulose paper waxed between the sections, makes it impossible to include either air or moisture in their manufacture.

The coils made with vaseline are peculiarly subjected to a breakdown, owing to the acids or alkalies frequently found in cheap vaseline, eroding the wire.

Repair of Coils—The apparent advantage claimed by each maker of one or the other being easily repaired if an accident happens, loses force when we know that either one can be repaired without much trouble, if necessary.

The Closed Transformer—In this type of apparatus, we have one with great latent possibilities in it, and it is unquestionably the coming apparatus. The fact that it is a low period machine on the commercial alternating current and for this reason requiring a longer exposure for a skiagraph, has worked against it heretofore.

Polyphase Currents—It is easily conceivable, however, that it will occur to our makers that the period can easily be increased by using a polyphase current which is available in many towns throughout the country. In this way we can send wave after wave through our primary

and ground the back wave. This will increase our periods to such an extent as to make it a close competitor to any open transformer upon the market today, and one that will exceed it in power.

By this method of construction, we would have no more inverse current than with the former coil. I have con-

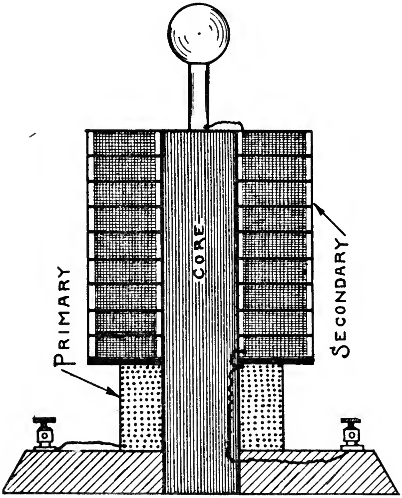


FIG. XVI. CLOSED TRANSFORMER

structed experimental apparatus along this line, in which a satisfactory skiagraph was made of the pelvis in 1-10 of a second, with a tube distance of four feet. A curious fact was noted with my transformers that I could force 32 milliamperes of current through a tube that would absorb only four with a powerful open transformer. Before I stumbled upon this fact, the target of three beautiful tubes was melted. With a period of 120, I was able to make a good Hip Joint skiagraph in 20 seconds, so that even with the drawbacks of a low period commercial current, it exceeds the great majority of open transformers upon the market today.

Alternating Current and Villard Tube—Where we use the alternating commercial current of 60 cycles, we have to use a Villard valve tube in the line to block all inverse current, which would otherwise ruin our tube by depositing platinum upon its walls. This tube allows a current to go through it one way, but blocks a current going in the opposite direction. The main objection to these contrivances in the past has been their small capacity, and their tendency to increase in vacuum. This has now been overcome by improved construction, and the attachment of a regulator upon them.

This type would have the immense advantage of being attachable to any alternating current without an interrupter, and could be used with the direct current with an electrolytic interrupter. They would be small in size very powerful, and have nothing to get out of order.

High Frequency Coil, Special—It has been known since the discovery of the X-ray that the High frequency current is available for X-ray work where the principle was utilized in a proper manner. Mr. Kinrade produced the first practical type, unfortunately of too small capacity for the commercial work expected of it, and for a time it fell in disrepute, until Dr. Strong applied the principle in a different way, and again increased the capacity, but still short of what was expected from an apparatus of this kind.

Portable Highfrequency Coil—During the last year, much thought has been given to the matter, and several small portable types have been evolved that satisfactorily settle the question of a small compact portable apparatus for this work. I have had the pleasure of testing a portable machine made by Mr. J. B. Wantz, the talented Electrical Engineer of the Victor Electric Co., and succeeded in getting a remarkable series of skiagraphs of all parts of the body that compared favorably with anything that can be gotten from a larger machine, and it is no exaggeration to say that as good work can be done upon it as can be done by the larger types, with about 60 percent

more exposure—a matter of small consideration when we come to think of the difference in cost, and its portability.

High Frequency Flame—Mr. Wantz has succeeded in developing a larger type that is a strong competitor to any upon the market today, and the end is not yet. There is no theoretical limit which confines these coils to any known size, as Nikla Tesla has demonstrated that a flame 68 feet can be drawn from a transformer of this type.

High Frequency Insulation—The principal difficulty in this type of machine is its insulation, as the current will pass through four inches of solid glass, and in fact, we have no known form of insulating compound that can confine this current to a conductor, and their construction is possible only by carefully calculating the self induction of each wire and winding them in such a manner that each turn is insulated by its own self induction—a problem for the finished electrician alone.

Leakage of Current—It is a curious thing to observe turns of wire running beside each other, charged with a potential sufficient to spark twice their distance, and no leakage taking place. One serious objection to this type of apparatus is the enormous leakage from the conducting wires, each wire having a beautiful brush discharge, owing to the ionization of the surrounding atmosphere. This is not vital, owing to the immense output of this type of coil.

Inverse Current—Second, having an inverse current, we require special tubes to reflect off the ray given off from the period we do not use. This is the most serious difficulty we have with this coil, as it prevents a sharp line of demarcation in the X-ray tube, and makes its regulation a difficult matter, to say nothing of an active field being thrown off in the possible direction of the operator. The tube manufacturer has as yet not solved the problem of a High Frequency X-ray tube, and it will probably have to be constructed with lead glass with a Bohemian glass window opposite the active field.

Static Machines—We have three distinct types, the Winshurst, the Holtz, and the Toepler-Holtz. These machines work upon several different principles and have been a source of mystery to Physicians as to why they generate a current.

If we will go back a ways and study **polarity,** we will soon find the origin of the initial current in these machines. We learned that by insulating a conductor and applying heat to one part of it, that we created an unequal molecular motion, and the current not being able to escape to the earth, the electro-motive force gradually grows greater until a spark passes and the current escapes.

Polarity in Static Machines—This is where we get our polarity in a static machine. We place upon varnished glass plates, metal sectors, with a raised center, and bring a brush to bear upon the center, while we revolve the plate. The succession of blows from the brush transmits energy, and the temperature rises in the raised portion of the sector. This gives us an unequal motion in the metal and polarity, is established. When we have succeeded in getting polarity, another principle is brought into play, called **Induction.** As we have learned before, wherever we polarized a conductor, a transfer of the electrical charge of the ether takes place, giving rise to a disturbance that passes out into space at a distance, depending upon the electro-motive force of the initial charge. We find that by charging the sector of a static machine and discharging and reversing its polarity each revolution, that a series of electro-magnetic waves are set up in the ether, the positive absorbing the negative charge of the ether, and the negative parting with its charge to the surrounding medium, so that we can conceive of a rotating static machine plate as being subjected to a bombardment of the minute electric charges of the ether upon one side, attracting the particles with enormous velocity, owing to the high electro-motive force, and giving out a charge upon reversal of polarity to the ether particles. In this way our current output is rapidly increased.

Electro-Motive Force of Static Machines—The diameter of the plates and the speed of rotation determines the electro-motive force, this increasing in inverse proportion to the square of the speed.

Ampere Output of Static Machines—The current output depends upon the diameter of the plates, and their number, and increases in inverse proportion to the speed and not in direct proportion, as has been asserted by some authors. In other words, if a machine running, say 500 revolutions per minute, gives us ½ a milliampere of current, 1000 revolutions a minute will not give us one milliampere, but only a 25 percent increase in current.

The only way to increase our current output, is to add more plates, or increase their diameter, the latter method not being wholly satisfactory, owing to the increase of electro-motive force as well.

Static Machine as a Generator—As a generator of the X-ray, the static machine has not been found wholly satisfactory, owing to various reasons. For instance, the large size of a machine required to do laboratory work, makes it unwieldy and cumbersome, while the induction given off from the machine is very distasteful to many patients, and occasionally gives rise to the so-called Induction burns.

Moisture and Static Machines—Second, they are not reliable, owing to their susceptibility to the amount of vapor in suspension in the atmosphere, necessitating the use of various chemicals to absorb the moisture within the case. There are many methods of overcoming this problem, and while they all accomplish it within certain limits, they all have certain drawbacks that render their use undesirable.

Calcium Chloride C. P. Dryer—This chemical dryer is usually recommended by the manufacturers as the ideal salt to use for this purpose, and as far as the moisture problem is concerned, it accomplishes its work well—still the fine particles of this salt are polarized and attach themselves to the plates, and, absorbing moisture, gradually cause an immense leakage of current to take place,

the plates feeling, after a few months' use, as if they were bathed in water. As this increases, the efficiency gradually deteriorates, until eventually the machine stops generating, and must be taken apart and the plates given a wash with a strong ammonia water, and relacquered with white shellac.

Acidi Sulphuric, Strong—A small dish of this acid will absorb moisture more rapidly than any other chemical, and if carefully used, does not cause any particular disturbance, although very dangerous to handle.

Freezing Mixture—It is a known fact that moisture will be precipitated if the atmosphere is chilled, and this fact has been used to keep a static machine running, where trouble is experienced only at intervals.

If we take a Mason fruit jar, fill it with ice and salt, seal it tightly, set it in a pan within the case, the moisture is precipitated upon the cold walls of the jar, as the machine keeps the air in motion. When it begins to generate sufficiently, the jar is rapidly removed and the case sealed up again.

In very moist climates, all of these means are at fault, and more drastic methods must be used. I had to solve the problem once, and did it in this manner: I put in a Schroeder bicycle valve, in the case both an intake and outlet. I took my air through a tube connected to a bottle containing calcium chloride C. P. Dryer, and a mineral wool fitter. This deprived it of moisture and dust particles. The air was sucked through this arrangement, and pumped out of the case through a soda solution and a wash bottle into a nebulizer tank, by means of a Victor Electric pump. This arrangement gave me pure, moisture-free air in the case, and removed all nitrous decomposition products from the case, and after removing the acrid nitric acid and oxide by means of the caustic soda solution, the air and pure ozone was compressed into the receiver, where it proved of incalculable value in the treatment of Pulmonary diseases.

Destruction of the Nitrogen—The contained air within a case is gradually decomposed with the formation of various products that have a destructive action upon the machine. Nitric acid is formed and various other combinations of oxygen, nitrogen, and ozone. These products attack the lacquer upon the plates, and if care is not taken to air the case from time to time, the whole coating may strip off the plates, owing to their oxidation.

Hygrometers—All users of static machines should have an instrument within the case and one outside in order to estimate the amount of vapor within it, and know when it is safe to remove the doors and ventilate. By giving attention to these details fairly good results may be had with a machine in ordinary office work.

The Static Machine in Skiagraphy—Where a physician has only his own work to do, it can be done with good satisfaction by these machines. A 16 or 24 plate machine gives enough current for all ordinary skiagraphic work, especially of the lighter parts of the body, and will do it as well as any other machine on the market. The exposure required is about 10 times as great as is required by a standard 12 inch coil, and for this reason is dangerous in body exposures, as more soft rays are given off that are absorbed by the skin, and it is dangerous to repeat an exposure again the same day, or within a few days of the first exposure. Lack of knowledge of this fact has gotten many physicians into trouble by causing an X-ray burn.

Static Machine in Radiotherapy—I have seen some of the most excellent work done, and believe if they are manipulated properly, as good work can be done with them as with a coil.

Possession of a good machine and a thorough knowledge of its use, makes it one of the most useful instruments a physician can have, as it has wonderful therapeutic properties when rightly used, that cannot be duplicated by any other known means in medicine. It is my conviction that it is a very much more valuable therapeutic agent than the High Frequency machine. Unfor-

tunately, however, in endeavoring to get a machine large enough for X-ray work, the manufacturers have made it too large for treatment purposes, as so much current is developed as to make it exceedingly disagreeable If these machines were built in such a manner as to use only two or four plates for therapeutic work and then be able to use the whole 16 or 24 for X-ray work, they could be used with much satisfaction to both physician and patient; as built at present, we must sacrifice our molecular vibration to cut down our current, as no patient can possibly stand the full force of a modern machine, without a violent erythema breaking out, to say nothing as to the discomfort that is experienced from the current.

Type of Machine, Selection—Of the three types of machine upon the market, we have only two in this country, the Holtz and Toepler-Holtz. The Winhurst machine is very popular in England, owing to its being the least susceptible to moisture. This is called the **Two Way** machine. In other words, the plates revolve in opposite directions. They contain very large inductors and a stiff brush gives a violent blow each time the Inductor passes. The transformation of energy taking place raises the temperature rapidly, giving us a marked polarity, regardless of the atmospheric conditions. From a mechanical standpoint, it has been found impossible, so far, to construct them in larger units than two plates successfully, which outclasses them for work in this country.

The Holtz Machine—This is a pure induction type of machine, no friction discs being placed upon the plates, so that the initial charge must be given from some other source, and this is ordinarily done by sealing into the case a small Winshurst or Toepler-Holtz, which is thrown out as soon as the plates are polarized. When we have charged our plates, the attraction of the particles that are free to move in the surrounding medium, gives us our current. As a generator, this machine is a beautiful instrument, as the current developed flows at practically the same even electro-motive force, which makes it exceed-

ingly agreeable from a therapeutic standpoint. The stinging and burning, so characteristic of the Toepler-Holtz is absent. The plates will remain charged so long as they are kept in motion, and this machine seldom bothers about changing its polarity while in use. Plate for plate, this machine is capable of generating about twice the current of other machines, at the same rate of speed, owing to the large stationary plates giving increased capacity. Its only real drawback is its susceptibility to vapor in suspension, making its use a source of annoyance in different parts of the country, owing to the amount of moisture in the atmosphere, still they are so perfectly constructed from a mechanical standpoint that some operators are using them with a great degree of satisfaction under the most unfavorable conditions. As a general rule, they will not charge if the Hydrometer stands at 55°, and some of the various dryers are necessary to keep them in operation.

The Toepler-Holtz — This machine combines three principles, the Friction, Induction, and Condenser. They are self contained, pick up their charge quickly under atmospheric conditions where the Hygrometer stands at 60°.

The revolving plates contain sectors with a raised center, which, under a succession of blows from the brushes, gives us polarity, which causes the polarized plates to attract or repel the free moving particles in the ether. Each plate delivers its charge to a condenser, which promptly polarizes the plates, and gives an impulsive wave to the current, that is delivered to the brushes. We get a higher molecular vibration to our current by this machine, and from a large machine it is almost unbearable, from a treatment standpoint. The best makes are wonderfully efficient for X-ray work, and are being used with satisfaction by thousands of operators all over the middle West.

It would be advisable to use one of from 16 to 24 plates for the requirements of an ordinary physican, as either one is able to do any reasonable skiagraphic work that will be required in general practice.

Motive Power—Some power is required to drive a static machine at a sufficient rate of speed to get its full output, and where possible, an electric motor should be used, as it is a clean source of energy, and always ready when required, at least a ¼ H. P. motor is required for this purpose, and some of the speed regulating motors like the Victor are to be preferred. It is now possible to get a regulating motor for the alternating current so that the old style speed controller is no longer necessary.

Water Motor—If the current is not available, we may use a ¼ horse power water motor. To do this successfully we must have at least 50 pounds of pressure, and a 2 inch pipe leading from the main to the motor, with a 4 inch discharge pipe. They are fairly satisfactory if we have a steady pressure upon the mains, but we can seldom use them under ideal conditions.

Gas or Gasoline Engine—Many physicians have been compelled to use a gas engine as a source of power for their static machines, and while it is noisy and disagreeable, owing to the fumes, yet I have received many encouraging reports regarding their use.

Much ingenuity has been shown by different physicians, devising means of running their machines. One rigged up a bicycle to be turned by his driver. Another one fixed up a treadmill and mounted his driving horse on it to furnish the necessary power, and maintained that it was a success.

Storage Batteries—It is a matter of historical interest to know that Prof. Trowbridge succeeded in working an X-ray tube upon storage batteries connected in series, giving about 80,000 volts, and controlled through a rheostat. This, of course, is impracticable, except from an experimental standpoint.

Theory of Open Transformer or X-Ray Coil—When we send a current into the primary windings of our coil, the inclosed iron becomes magnetic, the lines of force spring out from the core in all directions, and passing through the bobbins of wire on our secondary windings,

decay in heat, giving us a current that flows in one direction, through our coil.

When we have the iron saturated with magnetism, we break the current by means of a device called an interrupter. This lets the iron lose its magnetism, and the lines of force fall towards the iron. Their distance of travel is determined by the period of our interruptions. If they are slow, they may have time to reach the iron, and our current in the secondary would be a succession of flashes. If we increased the period, they are arrested in the air after moving a certain distance, and again forced out. Just as long as we keep the lines of force either moving away or towards the magnet, they see-saw back and forth through the secondary layers, giving us a current either in one direction or the other.

Some coils are calculated in such a manner that the strongest polarity is when the current is made through the primary, while others give the strongest induction current when the current is broken. As a general rule, the latter type is preferred by experienced operators, owing to the sudden energy of the flash.

Direct Current as a Source of Energy—If we are using the direct current to excite our coil, and some of the mechanical interrupters to break the current, we have another phenomenon to contend with, as the magnetic lines of force, passing through the turns of wire upon the primary during the break, generate an electro-motive force that causes a tremendous arc when the current is broken, and in order to prevent this arc, and absorb the energy, we must connect a condenser across the primary. If the capacity of this is properly calculated, no arc will take place when the current is broken.

Hysteresis—This is a law that controls us and allows us to use only a certain number of periods a second in our interrupter. It varies in different kinds of iron, and means the number of times we can magnetize and demagnetize

a given amount of iron in a second's time. The softer the iron, the higher rates of periods may be used, and the greater our coil output.

Alternating Coil—We can use an open transformer upon the alternating current by winding the primary layer in a different way. The self induction of the alternating current is much greater than the direct, and we cannot use the series winding in our primary, so that a parallel winding, with from one to three layers is generally used for this purpose. We do this by winding one layer clear across the core, and then the second in the same direction, as well as the third. By means of a switch, either one, two or three layers can be used as desired. In this form, the current travels over the iron only in one direction, and is used but once. The greatest power is obtained with one winding, while the most economical system calls for three layers. If we use the alternating current directly in the primary, we will obtain an equal period in the secondary, but of a higher potential. This is objectionable for X-ray work, owing to the destruction of the platinum target by the inverse wave, so that we must use a Villard valve tube upon the secondary current to cut out one wave, or we must use a valve upon the primary current that will change the direction and period. We can accomplish this by means of an electrolytic interrupter, or can convert the alternating into the direct current by means of Cooper's mercury rectifier, or an aluminum valve of 4 cells. Many manufacturers claim much better results where the valve is used, although I personally have failed to note any great difference in the output. This, of course, may be more pronounced in certain makes of coils than others.

The High Frequency Machine Principles—In this type of machine, we ordinarily take in the current at 110 volts, and run this through the primary of a closed transformer, and step the electro-motive force up to from 15,000 to 30,000 volts in the secondary winding. This is used to charge a variable condenser, the secondary current of

which is allowed to oscillate through a solenoid which encloses a resonator. We can increase our frequencies by decreasing the size of our condensor, or decrease them by varying the size of our spark gap. An immense amount of energy passes through this spark gap, and without it is constructed of non-arcing metal and contains radiating fins, or a water cooled electrode, the temperature rapidly increases and the metal is melted. Spark gap of a non-arcing metal, vaporizes in the gap, and ionizes the air to such an extent that a practical short circuit of the condensers takes place. This one point not being known by the average manufacturer, has been the reason why the high primary apparatus supplied to physicians has been of so worthless an order. The output of our machine can be varied by cutting in or out one or more layers of the solenoid. The only limit to the capacity of these machines is the ability of getting insulating material to withstand the current, as after a certain point has been reached, the current shows a preference of following the insulator rather than the conducting medium, and the only way they can be constructed is to wind them with the object of increasing the self induction to the greatest between layers, and if properly done, wires containing many thousands of volts difference of potential may be laid side by side without loss by leakage.

The Resonator gives us an oscillatory current, but ordinarily with a polarity very much stronger in one direction than in the other, and it is only by trial that we can determine which one to use on our tube.

High Frequency Tube—The tube must be a special one constructed in such a way that the inverse wave is reflected behind the target, a condition of affairs that gives us an actual X-ray field both sides of the target, and one that is likely to cause trouble to the operator if the tube is not screened in by some material that is ray proof. For treatment purposes with the X-ray, they are very successful, and I have made skiagraphs of all parts of the body, so that I know that they are effi

cient, although, as constructed at present, they have not been able to compete with the magnificent equipment of our laboratories. The time is not far distant, however, when they will become a formidable competitor to the present installation. If our tube makers can furnish a properly built tube, there is no reason why they should not supersede our present apparatus.

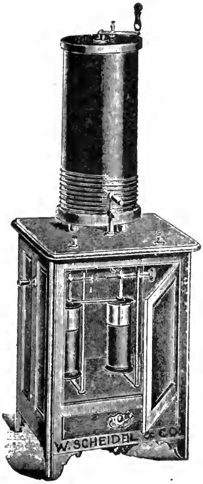


FIG. XVIII. RESONATOR

Use of the Static Machine—We must ascertain our polarity, and by watching the collecting combs, we will observe a star opposite each point on the positive side of the machine, and a brush discharge going up the plate for several inches upon the negative side, or by taking a stick, we will find that the current from a prime conductor will follow the wood around upon the positive side. After we have ascertained our polarity, it is better to keep the machine running slowly, and short circuit the sparking rods in order to prevent the machine from reversing is polarity by the time our tube is adjusted. It is generally better to use a spark gap on each side of the tube in order to give the machine greater electro-motive force. The size of the gap will depend upon the penetration we desire. The longer we make it, the greater the ray will penetrate the tissues, care always being taken that we do not sacrifice all of our current to make a useless electro-motive force, because one always re-acts upon the other, and with a static machine, we have no reserve current. We always need the full output in X-ray work.

As a general proposition, about ten times the exposure must be given with a 16 plate machine as is required by a standard 12 inch coil to accomplish the same amount of work with the X-ray. If we calculate the speed of the sta-

tic machine at about 250 R. P. M. approximately the speed used by the average physician in his work. If we desire to run our machine at a higher rate of speed with a full load, we will require a motor larger than the ¼ H. P. motor usually sold with these machines. All of these motors can carry an overload of 100 percent for a short time without danger, but should never be run for over five minutes at a time, or they are liable to burn out.

INTERRUPTERS

In order to obtain a practically uni-directional current in an X-ray coil, some method must be devised to interrupt the current very rapidly. While none of the different methods in use accomplishes this task perfectly; for practical purposes we get a current of greater volume and a stronger polarity when we make a contact, than we do when we break the current, so that very little inverse current runs through our tubes at the present time; a very serious drawback owing to the deposits of platinum from the target from the inverse polarity, as it is only from the cathode that metallic ions are thrown off in great quantities. If we have an inverse current the platinum thrown off from the target will rapidly blacken the tube and the layers become so thick that efficient rays cannot be obtained.

Construction of Interrupters—The problem of constructing an interrupter for the 110 volt current was a hard one as may be judged from the many different types in use at the present time. A short experience with the hammer break satisfied western manufacturers that no great measure of success could be obtained with it, that it was altogether too unreliable and troublesome to trust in the average operator's hands, it was early abandoned for something more efficient; although a measure of success has been obtained by three Eastern manufacturers in using this obsolete apparatus.

Rotary Break Interrupter—The first real progress made in the west was the invention of the copper and slate wheel type of interrupter, which consisted of a copper wheel with slate segments laid into it, one brush was allowed to travel upon the periphery of the wheel and the other upon the axle, considerable arcing was present, until we adopted the expedient of directing a jet of compressed air upon the arc, and later extinguished it by a flow of magnetic lines of force. This interrupter made possible the first commercial work in radiography of the deeper structures; it was eventually supplanted by the next type, which we will now consider.

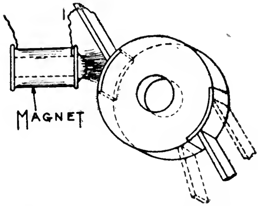


FIG. XIX. SLATE AND COPPER WHEEL INTERRUPTER

The Mercury Jet or Turbine Type—This interrupter placed the coil in such a position that it could compete with the static machine in fluoroscopy, it was such a good all around interrupter as made by the Allgemeine people of Germany, who brought forward the first working type of this interrupter for X-ray work, although antedated by Nikla Tesla and the principle patented by him. This wonderful wizard of electricity while experimenting with high frequency currents felt the need of some method of charging his step up transformers from the direct current, but being troubled with the arc he conceived the idea of making a contact with liquid mercury and absorbing the heat of the arc by means of some hydrocarbon fluid.

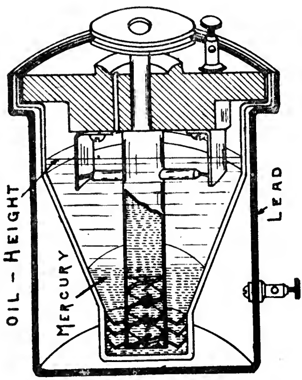


FIG. XX. MERCURY TURBINE INTERRUPTER

Hydrocarbons in Interrupters—There are a great many hydrocarbons that may be used, such as alcohol, kerosene, gasoline, etc., or even distilled water could be used. He constructed a motor and attached upon its armature a centrifugal pump and threw a jet of mercury upon copper segments.

The expense of an apparatus constructed in this way, to say nothing of its appearance, led the Allgemeine people to construct the centrifugal pump in a separate jar, and run it by means of an ordinary commercial motor. This invention gave a great impetus to the commercial use of the X-ray for both treatment and diagnostic purposes. It was found practical for the first time to make skiagraphs of the deeper parts of the body. Almost simultaneously with the advent of this interrupter, reports appeared in the medical journals reporting cases of deep seated diseases cured by the X-ray, and strangely enough failure to cure surface diseases that had heretofore yielded to former types of apparatus. The reason for this anomaly will appear later.

The sharp clear break we were able to obtain gave us a ray of considerable more energy due to the fact that we were able to handle heavier currents through our coils, and prevent the inverse current from going through the tube and blacking it; as was the case with all the former types when a heavy current was used.

This type usually gives about 3000 interruptions a minute and can handle up to 15 amperes, enough under ordinary conditions to do all kinds of work if a properly constructed coil is used. They give very little trouble with the exception of the belts breaking, and run for months without attention; but eventually all the free mercury will be found united under the influence of the electric current into an amalgam, with the wax from the kerosene, the iron from the pot, and the copper from the segments, and it must be submitted to the cleaning process.

Cleaning Interrupter—One of the most difficult undertakings if the technic is not well understood. The oper-

ator should first remove all gold rings from the hands if he values them, as gold will dissolve in contact with this amalgam like ice on a fire. Next if he has an old iron kettle he can pour the contents of the interrupter into it, and by applying heat drive off the mercury from the combination. Care should be used not to get it so hot that the mercury is vaporized or it will be lost. After cooling take the kettle out of doors and stir into the mass rapidly about one and a half ounces of pure nitric acid, immediately the kettle is surrounded with orange colored fumes (very poisonous), of nitrate of copper, after all the copper is dissolved out, place it under the hydrant and wash all the loose particles out, and the mercury is left pure. Dry the mercury with blotting paper and it is ready for use. In the meantime the pump should have pure nitric acid run through it to remove all the amalgam that is adhering to the sides, as a loose particle will make much trouble, destroy the temper of the operator and the usefulness of the interrupter. Brush off the segments with pure nitric acid to expose a fresh copper surface, replace the mercury, fill with kerosene and the interrupter is ready for work again for from 3 to 6 months. If the hands are stained in the operation, gasoline will remove it quickly.

Mercury Turbine for Alternating Current—It was thought when this interrupter was brought forward that we had obtained a perfect instrument, and it was satisfactory until we had perfected our coils, and wanted to use the alternating current that we found it was necessary to look further. We used in our experimental work with the alternating current, a mercury turbine with two segments run with a synchronous alternating motor, and while it demonstrated the practicability of the alternating current for X-ray work, it required too fine a technical knowledge of electricity to keep the motor and interrupter in perfect synchronism, so we turned to the electrolytic interrupter as the most promising field. Its principle was well understood, but no practical apparatus was in existence when we began our work.

Electrolytic Interrupters—We know when we send a current of electricity through a conducting solution that the medium is disassociated into its elements, we also know that gases of all kinds have common insulating properties, so that if we pass a current through a conducting solution gas will accumulate at both electrodes, more at one than at the other, we also know that the most active electrode is attracting hydrogen gas while the other is accumulating oxygen, now both hydrogen and oxygen may be used, if we do not use to much current; but as hydrogen is explosive the heat of the arc is frequently hot enough to blow off the end of the tube, so that oxygen gas is the best to use for this purpose as it will not burn or explode, and is ideal for this purpose.

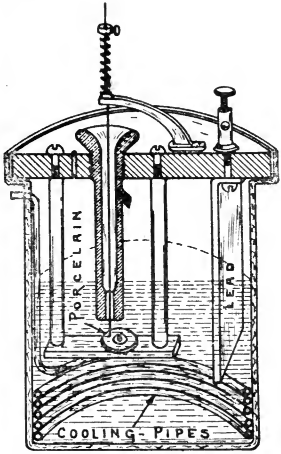


FIG. XXI. BURDICK'S TYPE OF ELECTROLYTIC INTERRUPTER

This interrupter is usually constructed by exposing a German silver or platinum wire through an opening, so that the fluid comes in contact with only a small part of it, so that when the conducting fluid is decomposed bubbles of gas accumulate around the wire and completely insulate it, causing an interruption of the current to take place. The magnetic lines of force collapsing through the primary gives an inverse current that disperses the gas, and exposes the wire again, and we have another contact flow. The more wire we expose the more gas it requires to insulate, so that we have a slow interruption, while by exposing a small amount we may get a very rapid series of interruptions. It has been found practical to get interruptions all the way from 800 to 60,000 a minute by using different methods of construction.

Consumption of Wire in Interrupter—The wire being upon the positive pole, necessarily it is rapidly destroyed, and in order to get a constant period of interruptions it is necessary to feed the wire as it is destroyed. This was accomplished by Dr. A. B. March by using clockwork, but it never became automatic until I constructed mine, where the wire is constantly fed by means of a spring. (See cut.) This interrupter was the result of considerable experimenting in order to perfect a type that might be used upon any voltage of the direct, or any period of the alternating current. After ten years of constant use I am happy to say that it is a success, and may be readily adapted to any safe current you may bring into a physician's office. It is absolutely automatic and may be relied upon to do its work while the physician is elsewhere, a necessity considering the number of physicians that are being burned by standing too close to the apparatus.

Heating of Fluid in Interrupter—It was found that the fluid in all electrolytic interrupters was heated rapidly, owing to the large currents used; in order to overcome this I placed in cooling coils, through which water was allowed to flow from a tap, this was found efficient to keep the temperature about right for practical work, and removed from the office the fumes of sulphuric acid when the acidu'ated water began to boil.

Noise of Interrupter—The noise made by this interrupter has been suppressed by placing the jar in a box full of mineral wool. Physicians who have been having trouble with their interrupters cannot do better than make one like it as it is not patented. Several things require attention occasionally with this instrument, the current shows a disposition to excavate the porcelain tube and cause the interrupter to stick. This may be obviated by grinding down the end on a corundum wheel when the excavation begins to interfere with good work. Second, the amount of evaporation should be made up, and about once in three months the fluid should be filtered and the electrodes cleansed, and a small amount of acid added. I have found

also that the point of the wire may drill a hole in the porcelain anvil and cause bad work; I overcome that by putting on a porcelain disc with a lead or hard rubber screw, and expose a new place on the porcelain when required.

Solution for Electrolytic Interrupter—The solution for 110-volt current direct is, sulphuric acid c. p. 1 part, water 6 parts. From 25 volts down, an addition of sulphate of magnesia should be added, in order to render the solution conducting. And just in proportion as the electro-motive force decreases, just in that proportion should the magnesia be added, and the distance between the electrodes decreased. If it is necessary to use 220 volts or over, we must cut down the amount of sulphuric acid, as we will not get electrolytic effects if the solution does not offer a certain amount of resistance to the passage of the current. The substitution of porcelain for glass tubes in this type of interrupter was the beginning of the success we attained in our experiments.

Diaphragm Interrupters—Prof. Lodge conceived the idea that if a bubble of gas would insulate a conductor while surrounding it, that it should do so while passing through an opening. We know that the gas passes from one electrode to another through the solution.

He constructed an interrupter (see Fig. XXII, cut) by using a lead jar with a suitable cover, placing through the cover a porcelain jar containing a lead electrode, and a perforation in its side submerged under fluid, the jar being two-thirds full, sulphuric acid, one part to six parts water. It was his idea that the bubble of gas, while passing through this opening would cause an interruption of the current and such proved to be the case, making an absolutely automatic interrupter, with no consumption of metals, and theoretically perfect, as the different periods of interruptions were made by using bushings of hard rubber, allowing more or less gas to pass. Unfortunately it was found from a practical standpoint that the gas showed a disposition to stick in the opening, requiring vigorous shaking to dislodge it.

This interrupter was taken up by the Heintz people who overcame the difficulty by combining the slate and copper wheel with this interrupter; in other words, interrupting the current before it went into the interrupter proper. This has worked out as a great success as the impulsive wave given the current by the slate wheel propels the gas through the opening, and prevents any inverse current from going through the tube. It has since been found not necessary to use the slate wheel, as the trouble is avoided by drilling the hole through the porcelain on an angle and not directly through. This fact was accidentally discovered.

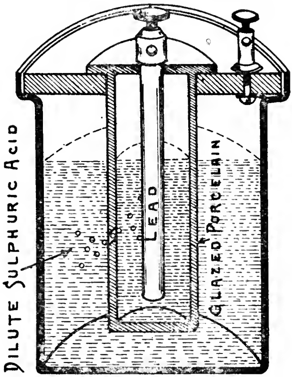


FIG. XXII. LODGE TYPE OF ELECTROLYTIC INTERRUPTER

Dr. Custer's Interrupter—My friend, Dr. Lester Custer, of Dayton, Ohio, has solved the problem of the Lodge type of interrupters by using a quarter of a barrel, which is lined with lead, for one electrode, and filling that with bottles which he constructed of porcelain, walls of different thickness through which he drilled holes upon an angle and of different sizes, and leading a wire from the electrode in the bottle and up to the switchboard, he was able to choose any bottle as he desired, each bottle giving a different interruption usually he started with a quick, fine interruption, and by swinging the switch lever over until it was allowed to remain upon the bottle which gave the right period of interruption for the work in hand. A construction of this kind is ideal, and may be located at any distance from the operator. The great amount of fluid in the tub, the absence of an unsightly object in the office, as it may be located in the basement, no consumption of

metals, as lead only is used, and no attention necessary except to make up the amount of evaporation from time to time as may be necessary.

Electrolytic, Advantages of—The electrolytic interrupter has an advantage over any other kind, because no troublesome condenser is necessary with the coil; further, they may be readily adapted for any kind of a current, both direct and alternating of any period and voltage, without any radical change in construction, while the initial cost is vastly in their favor; they may be constructed to handle just as heavy currents as may be desired and have in practice worked from ½ to 60 amperes of current.

Soon after the invention of these interrupters and skiagraphy had become a fine art, operators found a peculiar phenomenon would develop in certain cases; when they attempted to make a skiagraph of the body, loss of sharpness of the bones were very often noticed in patients that weighed over a hundred and seventy-five pounds; the outlines of the bones would look fuzzy and woolly and the plate have the appearance of a chemical fog.

Indirect Rays—Considerable experimenting was carried on by different operators, and they never could locate the source of the trouble, until eventually it was found that the interrupter was at fault. It was found that when the ray was sent through the body with great velocity that the tissues became radio-active and gave rise to rays, having similar properties to the X-rays in the chemical effects, and further, that these rays were thrown off, not in the same plane, but at an angle to the rays from the target, and further experiment showed that if the period of interruption was kept below 800 a minute this phenomenon was not noticed and this necessitated further research for an interrupter with which we could control the period at will. We accomplish this task by modifying the old Faucault interrupter to modern conditions.

Faucault Interrupter — This is merely a peculiarly shaped bottle upon a movable platform so that it can be raised or lowered at will, the bottom of which is perfor-

ated and filled with mercury, with a platinum wire through the bottom of the bottle, which is covered with kerosene of one hundred and fifty fire test, and a steel or German silver wire rod mounted upon an arm that travels in a slide and is given an up and down motion by the means of an eccentric driven by a motor; by controlling the speed of the motor we can control the number of interruptions from sixty to four thousand a minute, while by raising the bottle we can control the amount of the dip of the rod in the mercury so that we can modify the work of the instrument within wide limits. (See cut.)

Flash Interruptions—It was noticed that a sudden flash of X-ray has greater penetration and chemical power than the heavy fluorescence that is given off from rapid interruptions. There is the interval of time giving the current, time to completely magnetize the iron of the coil; the result is a powerful magnetic shower that sends the current of the secondary through the tube in greater volume and with terrific force, strongly polarizing the electrode, driving the corpuscles with terrific velocity against the target with the result that we get a flash of X-ray of greater chemical value and of greater penetration. The period between the contact gives time for the target to radiate off the heat from the disc before the next flash comes, so that the tube is able to stand sufficient energy to give the plate a normal exposure, instead of compelling the operator to under expose and try to equalize things by special development. This is of the utmost importance, because it is now a very difficult thing to get a tube that will do good skiagraphic work. We are able to pick out a tube occasionally by running over a great number, so that they will do very heavy skiagraphic work, that is beyond the reach of ordinary operators who have no facilities for picking over a number of tubes for this purpose.

Our American made tubes are now very satisfactory and can be depended upon to stand up under the heaviest skiagraphic work. The heavy jacketed target is the one in general use.

Metal Targets—It is to be hoped that some physicist will discover an element to use in a tube for a target that is non-metallic, that is unmeltable and which does not give off gas.

A discovery of this kind would be of the utmost importance to X-ray workers, because platinum is such a disturbing element to the tube. The ionic platinum is thrown out in the shower by the inverse current from certain types of apparatus, absorbing the free corpuscles in the tube, and, therefore the vacuum is always disturbed, rather tending to get higher all the time. The ordinary regulator which is put in for raising the tube always has a platinum —iridium spiral, and they make more trouble than they are worth, as nearly all operators desire to reduce and not increase their vacuum under present conditions.

It can be readily seen from the foregoing that it is not possible for laboratories to do ordinary commercial work, without having several kinds of tubes to fall back upon in an emergency and no one knows until he has run a laboratory for a few years, the unreasonable things that medical men will expect from an X-ray operator. It is no uncommon thing for a man weighing from 250 to 300 pounds to ask for a skiagraph of the kidneys or liver for gall-stone or calculi, and under our present system of development we generally succeed in getting a good plate, although no laboratory is looking for just that kind of cases.

Ribbon Interrupters—Within the last year Mr. J. B. Wantz, electrical engineer of the Victor Electric Co., has designed a ribbon type of interrupter, for use in connection with their new lines of high frequency coils. It has a cooled gap of non-arcing metal, that will run all day without excessive heating or danger to the apparatus. It needs no attention, and is self starting.

Rectifiers—For the alternating current there are a number of instruments upon the market that are called "rectifiers," they depend upon the fact that aluminum has a valve action upon the current, in other words, it

will allow a current to flow away from it when immersed in a suitable solution, but will not allow one to go back owing to the insulating properties of the gas that accumulates around the aluminum. An aluminum electrode is submerged into a fused solution of phosphate of soda and one wave of the alternating current is blocked, allowing the other wave to flow. But by constructing four cells both waves may be used. They are very successful up to about 20 amperes of current, but require a cooling apparatus to keep the temperature within reasonable limits.

Churchill Rectifier—A very ingenious and complicated apparatus is the Churchill alternating rectifier and attempts have been made to apply it to X-ray work, but with indifferent success as the apparatus is not sufficiently flexible to respond to the demands upon an X-ray coil at the present day. The same can be said about the large rotary transformers, that some physicians have been persuaded into buying, while they are effective within reasonable limits they are unnecessary and very wasteful of energy. Physicians should be very careful about absorbing all the information vouchsafed them by agents who have something to sell, because it is of great interest to the agent to make the bill as large as possible to increase his own percentage, and, as physicians are notoriously bad business men they are persuaded into buynig too much archaic apparatus which only takes valuable space and serves no useful purpose.

Low Reading Milliamperemeters—One of the great difficulties X-ray workers have to contend with is the absence of any exact method of measuring the secondary current so as to compare it with the work of other operators; we have had the "hot wire" milliamperemeter of French construction, and until the last year the work of the tube was measured by means of the fluoroscope, but during the past year Mr. J. B. Wantz, the Electrical Engineer of the Victor Electric Co., has developed a new low reading hot wire instrument that is very reliable, and cannot burn out under ordinary use, and an intragrating me-

ter may be obtained if required at present as this instrument indicates any inverse current in the coil instantly, and while in operation it measures the amount of current that the tube is absorbing, and has a further advantage of indicating instantly any inverse current and has succeeded in detecting defects in the coils, that have defied the most delicate measures heretofore to locate the reason why they would not do good X-ray work.

Cause of Inverse Current—Many coils will give an inverse current or a reverse discharge and not be recognized, as the tube suddenly seems to lose its vacuum, but we were not able to find any reason for the phenomenon, the tube being blamed for it. Since the use of milliamperemeters it has been found that the trouble is either due to the use of wire for the magnets that has not been thoroughly annealed or the periods of interruption are far too rapid for the quantity and the quality of iron used. It is now possible to standardize for the first time the amount of X-ray to give for both skiagraphic and radio-therapeutic work, so that a beginner may have a blazed trail to follow and not be compelled to follow blindly some operator's technic, being able only to half comprehend his work and not follow his mental process which is the essential secret of success.

Measuring Quantity of Ray—We can now measure the quantity of X-ray we are giving in a given case and can regulate the degree of penetration as well, by increasing the resistance of the circuit. It will make no difference whether the operator has a coil or a static machine, just as long as he knows the exact amount of current going through his tubes, and the distance between the target and the surface of the body he will be able to know just how much X-ray the patient can stand, eliminating the element of guess work so much used in the past. Since these meters have been brought out, old operators have been able to demonstrate to physicists

the phenomenon. They have known themselves, that the quantity of X-ray given out from a soft tube is many times as rich in chemical value as the high tube.

Meter Indicates Degree of Vacuum—The meter will indicate instantly if the vacuum of the tube has changed while in use causing burns to take place before the operator realizes that anything is wrong, this is especially apt to occur where an operator depends upon one or two tubes to do all this work.

Capacity of X-Ray Tube—The operator when he uses the milliamperemeter for the first time will be surprised at the small amount of current used for X-ray work, and it is found in practice that the current raises from one to thirty-five milliamperes, depending upon the vacuum, the hard tube taking less and the soft tube more.

It is a rare thing for an operator to use more than one milliampere for radiotherapeutic purposes, while he may use from four to eight in skiagraphic work.

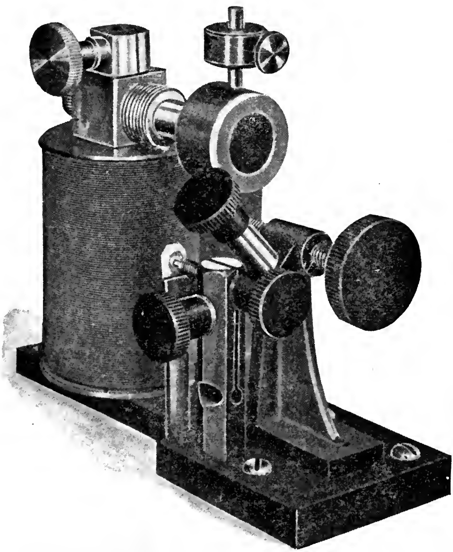


FIG. XXIII. MECHANICAL BREAK INTERRUPTER

Mechanical Interrupter—Through the courtesy of Mr. James G. Biddle, of Philadelphia, I shall be able to present to my readers the electrotype of the best mechanical interrupter which depends upon magnetic energy to operate.

This mechanical interrupter is self-starting, it is sufficiently automatic in its action that it is safe to go away and leave it temporarily, a great consideration for operators who have considerable work to do, as it is a fact that any operator who makes a practice of staying in the room where an X-ray apparatus is in operation is sure to be badly burned in a short time. The only protection for operators is in turning the field in the other direction and keeping away from it. No operator should use the fluoroscope, except at possibly long intervals, as the series of terrible accidents which are happening to operators all over the country shows that there is a lamentable lack of common sense, as ex-operators condemn the X-ray in unmistakable terms, but the trouble is due only to their own carelessness and as it is common knowledge that too much X-radiation is destructive to organic tissue and, while it is true that the dosage can be controlled, within a reasonable limit while treating a patient, no one can estimate the amount of ray a careless operator may absorb in the course of a busy day.

TUBE STANDS.

The market is flooded with alleged tube holders constructed by men who have never had to use the X-ray in practical work, and consequently many are found wanting when we attempt to use them in practice.

The best class of tube holders have three heavy legs rotating at ease 10 inches from a common center, the upright should be made of steel tubing, preferably about one inch in diameter, having a positive up and down adjustment. The arm that carries the tube holder proper should be clamped by a simple but adjustable clamp to the upright rod, so that it allows the tube to be quickly

thrown out of the way when through using it. A wooden or hard rubber support should be carried at least one foot above the tube arm, and should support a cross piece, of either wood or rubber and have clips on the ends so as to keep the cords above the tube, and thereby prevent them from falling near the patient or the sides of the tube. The whole mechanism should be calculated so that it will work quickly and smoothly when required. A tube arm over 18 inches is usually a serious handicap to good work, as a certain amount of vibration is imparted to the tube from the building, or, its unstable mounting. Long cords should be used so that the tube stand may be moved around to accommodate both the operator and the patient. Our stand must be substantial, in order to support the great weight of our commercial tube shields, otherwise an expensive accident may occur.

Diaphragms—Defective interrupters giving rise to inverse currents through the tube, made it necessary to screen off part of the active field of rays while making skiagraphs of the body, and for a time it was thought by many operators that they were absolutely necessary for sharp definition.

Improvements in interrupters and coils, however, have made their use of questionable value, and they have fallen into disuse in many laboratories, being rather troublesome to manipulate, and taking up too much valuable space.

In their simpler form, they consist of a lead sheet with a perforation about three inches in diameter, placed four inches below the tube, cutting off all but the most parallel rays from the target. In their more improved form, they are made of a lead lined cylinder five inches in diameter, and eight inches long, with a suitable adjustment to cause compression of the parts, serving a twofold purpose of cutting off the induced radiation, and fixing the part to prevent motion. Some beautiful skiagraphs have been made by this process, showing stone in the kidney, gall duct and bladder. The field covered, however, is so small

that a possibility always exists that something might be overlooked in the vicinity not covered by the rays, and not infrequently a disagreeable ground through the apparatus takes place, giving a patient a shock long to be remembered, and not considered good form by the advertising manager.

Tube Shields—These diaphragms have appeared in another form for a different purpose. They are constructed of alternate layers of felt, tin foil and gum shellac; they are made to enclose the entire tube and have an opening opposite the target in which are fitted metallic tubes of different diameters. The object of this combination is to give a pencil of active rays covering a different sized field to be used in the Radio-Therapeutic treatment of disease, making the use of lead shields unnecessary to protect the sound tissues. They are extremely useful in many cases by allowing the operator to get into places very difficult of access with the present clumsy X-ray tube.

The serious objection is their weight and the fact that they enclose the tube so completely that its action cannot be watched. It is urged in their favor that it protects both the patient and the operator, a consideration, if the latter is trying to do his work with a troublesome piece of apparatus, requiring his presence in the room—something that must be avoided if possible, as constant exposure to the ionized air in the operating room is not compatible with good health, even when not directly exposed to the active field from the tube.

The tube shield as now made, while inconveniently heavy, are almost indispensable to an operator, and where possible, should always be used. They give a good definition in a skiagraph, and protect the patient from any unnecessary exposure of parts not directly under examination. It also masks the ray in such a manner that the operator is protected from its injurious effects.

Compression Diaphragms—Some very beautiful work has been done by this instrument that cannot be duplicated by any other known method.

This is usually a metallic cylinder, about 4 inches in diameter and 8 inches long, with an opening to hold a tube in the proper position above, and mounted upon a lever, to cause a compression of the part about to be skiagraphed. Only a small pencil of rays from the tube which are rectilinear are used. The plate is put under the part, and the compression tube forced down as far as the patient will tolerate it. This approximates the parts and brings the tube closer to the plate and hold the parts steady during the exposure.

We get a beautiful definition of tissue; stones stand out with startling clearness, while the details of the bones

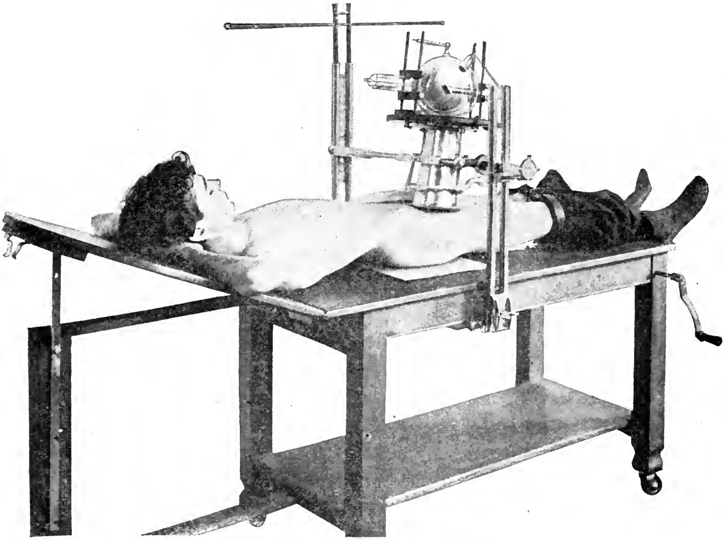


FIG. XXIV K. K. COMPRESSION DIAPHRAGM

are very closely brought out. The only serious drawback is the small view we obtain and the liability of overlooking something important in the immediate vicinity. I have been able repeatedly to make out the outlines of a kidney by this means.

RADIOTHERAPEUTIC TECHNIQUE.

If we canvass the literature, we will find that nearly every operator has a technique differing in some essentials from others, and to a new man going into this line of work, much confusion results. If it was possible to study the conditions under which each operator works we would have no difficulty in explaining his special method to our satisfaction.

When it is considered that apparatus is used that is by no means standard, and varies all the way from an eight inch coil with a hammer type of interrupter, run at 18 volts to a 60 inch coil with an electrolytic interrupter, of greater capacity run at 220 volts, we can begin to gather an idea that possibly they would differ in their conclusions. Our static machine operators use all the way from a machine of two plates to eighty revolving plates in their work, and run them at a speed varying from 200 to 2,000 revolutions a minute. Considering all of these facts, it must appear to the reader that it would be almost a waste of time attempting to devise a technique that all could use in their work. For practical purposes, I still believe the one advanced by myself gives the best working formula in radiotherapy.

Technique—I reduce the tube below the line where it gives off X-rays in series with the machine, and by putting spark gaps each side of the tube, we discover that we get the X-ray, and the larger our spark gap the greater our penetration becomes.

By this technique, we are enabled to get a radiation that we can drive at any distance in the body, up to seven inches, and allow the energy to be absorbed at any desired place.

This simplifies our work for a certain class of diseases, as Lupus, Sycosis, and certain kinds of Epithelioma, as we can concentrate our rays upon the diseased tissue without modifying or injuring the tissue in its neighborhood.

The question of how far the penetration should be carried is one that will not respond to dogmatic rules. Every

case is a study by itself, and the sooner this is learned, the quicker the Roentgen operators will obtain success in using this form of energy in the treatment of disease.

In certain diseases as Lupus and Epithelioma, it is seldom necessary to push the treatment to a full reaction, as the disease disappears upon the appearance of a distinct tan, or in certain cases before we reach this condition. This is true of the ulcerous type of the disease, more than that which shows tumor growth. With the latter we must carry the process on until a distinct reaction is produced. This lasts for from ten days to two weeks, and upon its subsidence, a disappearance of the disease results. With eczema, pruritus, etc., and in ordinary skin lesions, it is rarely necessary to produce a dermatitis and as far as my experience goes, is not good policy, owing to the neuritis that is already present, and I have observed severe burns following its use in this condition.

Culminative Effect of X-Ray Exposures—Many operators have made the distressing discovery that profound changes are made in tissue that has been exposed to the X-ray, and forgetting to take advantage of this knowledge has resulted in numerous damage suits for injuries received.

Certain diseases, like eczema, and psoriasis, if properly treated, and necessary caution given to avoid all irritants upon the surface, may recur several times, if the patient is not warned to keep the parts away from aniline dyed goods or strong alkalies.

The beautiful way the disease yielded to the first treatment, is a strong temptation to use the same method again, and if not cautiously used, will cause a destructive burn with a very little treatment.

A surface that has once been X-rayed, will not stand twenty percent of the first exposure the second time. If operators remember this fact, good results can be obtained the second or even third time, using a greater amount of caution each time.

A personal experience has borne this truth into my mind forcibly. A severe case of pruritus ani, brought on from the liberal use of calomel, orthoform, carbolic acid, etc., of a rectal specialist, while the patient was undergoing a treatment for alleged pockets, piles, etc., causing a local pruritus that made the patient's life a nightmare. He presented himself for treatment, and before I took the case, made him agree that under no circumstances would he allow any physician to again treat him for rectal disease. He promised and was given six treatments, when the trouble all left him, and he disappeared for about nine months. A letter from the specialist brought him to the office, where a request was made to inspect the work, a speculum with carbolized vaseline was introduced, inspection made, and in 24 hours the patient was in a deplorable condition from the return of the trouble.

Local means of relief were tried for several weeks, when he presented himself again for treatment. After hearing his story, I refused to again have anything to do with the case, telling him plainly he deserved just what he was getting. He went to another operator, who has an excellent reputation, and was treated with the X-ray, resulting in a terribly destructive X-ray burn around the anus. This happened two years ago, and the patient is not well yet—an accident that is going to happen with increasing frequency in the future, owing to the extensive use of the ray for the treatment of certain diseases.

It would be the part of wisdom to inquire carefully into the details of each case that presents itself, and ascertain if they have ever had a treatment of this character upon the part, and if so, the ray must be used with the greatest caution.

Anesthesia and Radiation—There is beginning to grow a disquieting thought that general radiation of the body produces some change that makes the use of an anaesthetic a danger to the patient. Just why this is so, has not as yet been determined. We are aware of six cases of death from anaesthetics upon the table, where a prolonged

raying had been given to the patient previously for systemic disease, where the ray is used locally, no special effect is noticed. A little more observation upon this point is demanded.

Sudden Death Following Radiation—Several cases where death occurred either during an exposure or shortly afterwards have been brought to my attention, one case being exposed for an aortic aneurism to fluoroscopic examination, when he was taken with a "sinking spell" and carried to bed, where he had a high fever with delirium for several days. No special importance was attached to the X-ray and another attempt was made to examine the man by the fluoroscope. This was followed by a scream, a gasp, and death took place instantly.

The cause of death in this case is a mystery. It opens up several possibilities for consideration. Did the man get an accidental "ground" from the secondary of the transformer, through some pipe that ran under the floor? Or did he die from natural causes? These two questions would be important, if an answer were possible; unfortunately, the operator is rather inclined to be noncommital regarding the case, and for these reasons, speculation will not furnish much information, quite a large number of cases showing great distress during and following an X-ray exposure, have been observed.

The Effect of the X-Ray upon the Brain—A question has been raised in many operator's minds, as to just what relation, if any, the X-ray has to several cases of temporary aberration, following the making of several skiagraphs of a skull. The phenomena has been observed by several operators, and it would seem the part of wisdom not to expose the head except in those cases where it is absolutely necessary, and then do our work with such a degree of precision as to prevent a repetition of unnecessary exposures. We, as yet, hardly appreciate what a powerful agent we have in the X-ray, and while we have much knowledge of its value, we have very little regarding its remote dangers.

The general improvement taking place in apparatus is giving us an instrument, with greater power for good and evil, and it would be the part of wisdom not to use this radiation except where it is imperatively indicated and even then using it with great caution until we learn the power of the apparatus we use.

THE USE OF BISMUTH SUB NITRATE WITH THE X-RAY.

Many operators are not aware of the many uses we can make of this salt in skiagraphy and fluoroscopy. We must get a salt free from arsenic, or it is quite possible a serious result might occasionally occur.

For stomach diseases, we mix about one or two ounces of arsenic free Bismuth with a corn meal mush, and if we desire a fluoroscopic examination, the patient is put into a perfectly dark room with the operator for at least 20 minutes before the examination is made. The tube is adjusted from behind, so as to take in such parts as we desire to examine, some provision being made to raise or lower the tube as may be desired. The patient is instructed to swallow the mixture slowly, and each mouthful can be seen as it finds its way down the Esophagus and enters the stomach.

In this way, we can ascertain the presence of a stricture of the esophagus, and accurately locate the position of the stomach, the outlines of its walls, its size, and the relative position it occupies in relation to its normal plane, the outlines of tumors in its walls, and the presence or absence of peristalsis.

We make many remarkable discoveries by the method. Many times, we find the stomach rests upon the pubis, or may occupy a vertical position, its pyloric end being prolapsed until it is in Douglas cul-de-sac. On further examination, three hours later, we find the outline of the colon, its sacculated form and position, the presence of accumulations or tumors, in its walls, and strictures of

the small intestines. About five hours later, the size and position of the sigmoid flexure of the Rectum.

We can skiagraph these conditions, if we have a powerful apparatus, so as to give a practically instantaneous exposure, and get a plate that can be studied carefully and learn much. This is perhaps the safest and most certain way of doing this work. Holtz has shown some beautiful plates made by this method.

The technique consists of a Bismuth meal, the plate being placed behind a person standing, a penny being placed on the navel, and an instantaneous exposue made. This gives an exact position of the abdominal contents at the time of exposure. Several exposures are made from time to time, tracing the Bismuth on its way through the bowels, care always being taken to err on the safe side.

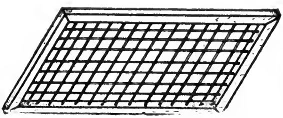
Bismuth in Sinuses—We can mix up Bismuth with vaseline and white wax, with a melting point of 100 degrees, and by means of a metal syringe with a Valentine tip, forcibly inject the mixture in the fistulae. Considerable tension may be caused, and by applying a hot water bag, the mixture will find its way to each ramification of the sinus. It usually requires about 15 minutes for the emulsion to spread out, and by applying an ice bag for 20 minutes. it solidifies in position. A skiagraph is now made, and we have an accurate map of the infiltrated area, enabling the surgeon, if thought best to follow the entire track. By introducing a coloring matter like methylene blue to our mixture, no difficulty is found in following the diseased tract with precision. If the mixture is chilled just before operation, it may be removed with little trouble.

If we desire to remove the mixture, a hot water bag, with compression, will do it very quickly. This method has been followed in fistulae following laparotomy, and enables the surgeon not only to get a fair idea of its size and distinction, but to remove the entire tract without opening into the infected area.

By this means, we can trace a fistula that is supposed to be connected to the vertebra, hip joint, or a vital organ, and either confirm or show the fallacy of the diagnosis before some ill advised surgical procedure is attempted. To watch the working of the process in real laboratory work would astonish the average physician. The dentist, orthopedist, gynecologist, and surgeon have found cases where the process is indispensable to successful diagnosis.

Bismuth Emulsion in Bladder Work—Many times, especially in women after confinement, a rupture of some of the coats of the bladder, and a narrow necked communication connects with a larger cavity that forms outside, so that in a rough way, the bladder could be called dumbbell shape. This is the cause of an obstinate cystitis that will not respond to any ordinary treatment. The cystoscope furnished no information, the rupture being called an ulcer, and treated as such.

With the Bismuth emulsion, we get a beautiful view of the interior of the bladder, the outlines of its walls, and can gain information that cannot be obtained in any other way.



WIRE LOCALIZATION SCREEN

Several cases of this kind have presented themselves to my laboratory during the last 10 years, where a very peculiar anatomical condition was present. In one case, the rupture had occurred upon the anterior aspect, and a sac had formed that was narrow and extended upwards to the umbilicus. Two cases with a wide sacculation were observed that baffled many surgeons until the skiagraph showed the condition.

This process is not generally well known, and few operators have used it.

INSTANTANEOUS SKIAGRAPHY.

This subject crops out about once in so often in different parts of the country, and great value is attached to the discovery, yet today few laboratories are using the process, although every old operator is familiar with it.

In order to work this process, a number of details must be attended to before success can be achieved. Some coil with a variable inductance, an electrolytic interrupter, the 220 volt alternating or direct current, a fast plate, and a special developer.

With a combination of this kind, it is possible to get a hip joint in 1-10th of a second. That is, we get a good outline of the bones with no details. The process is used in thoracic, and abdominal skiagraphy, and at times with beautiful results. By this means, we succeed in getting the imprint of the parts without motion.

Few laboratories use this method, owing to the danger to tubes. Occasionally the cathode stream will bore a hole through the target and ruin it.

Physicians in this country are not educated up to paying for fine work, the element of cost seeming to be the only thing they take under consideration, and operators simply will not risk their tubes in this kind of work, for the fee they are able to obtain.

Technique of Instantaneous Skiagraphy—In selecting a tube for this work, one with a diffused focus of 3-16 of an inch will give the best results; even with this, one exposure may excavate the target to a depth of 1-16 of an inch. It is seldom that a tube can be used more than four times with this amount of energy without being ruined.

The process may become popular eventually in some of our charitable institutions, where money comes easy and goes easy. It is a fine process for the average operator to leave severely alone.

Intensifying Screens—There is one method of doing the work by the aid of intensifying screens, usually made of Tungstate of Calcium. This is placed in contact with the plate, and the ray is intensified by the fluorescence of

the salt, its light acting directly upon the silver emulsion. The serious drawback to the process has been our inability to get a screen which was fine enough grained. Otherwise, the plate looks as if it had the smallpox.

Several operators claimed to have solved the problem of making these screens. I have not had the pleasure of seeing any of their work, however, and very much doubt that they have succeeded as well as they claim.

When it is thought best to use the process, use one of the most rapid portrait plates, attach the coil to the 220 volt circuit, use a tube that has been well seasoned by use, and an electrolytic interrupter so timed as to avoid flickering in the tube.

The machine should be used carefully for a few seconds in order to warm the target and glass, and to adjust the Inductance so the tube balances perfectly with the current. Place the plate under the patient, adjust this in the proper place, cut out the resistance in the circuit, instruct the patient to take a long breath, and throw on the current with a long handled knife switch. The time of contact to be determined by the difficulty of the work. Nearly all parts of the body will receive enough X-ray in less than 5 seconds to profoundly affect the plate.

We must use either an amidol, metol or pyrogallic developer, so proportioned as to work well with ordinary instantaneous work.

Penetration—The question has been discussed pro and con among physicians concerning the possibility of the X-ray having any medicinal effect below the surface, and many men not actually engaged in the work have seriously questioned the possibility for the X-ray to have any effect upon deep-seated disease. This question has been solved to the satisfaction of regular operators for several years past.

Effect of Ray on Spleen—Any physician who has seen a spleen filling almost the entire abdomen in leukemia disappear rapidly under the X-ray treatment, when no other means had succeeded in reducing its size, and those who

have watched the treatment suspended after the spleen has shrunken over one half, have also seen that the retrograde process stopped with the X-ray, and resumes its course as soon as the ray is used again, can be persuaded to believe that the X-ray is not without an effect upon deep-seated disease.

Chemical Effect of Ray—It is a demonstrated fact that the radiation has chemical qualities, that it will pass through the body and retain much of its chemical energy, as is demonstrated many times a day by skiagraphy. The penetration of the ray being under the absolute control of the operator he can calculate the depth and control his penetrations so that all of the X-radiation will come at rest at the place selected. No one can seriously question that the absorption of chemical energy is capable of doing work where its progress is arrested by organic tissue.

Absorption of Ray—There are many facts at hand that teach us that the ray can be as effectually used for deep work as well as where the surface alone is affected. In a case of scalp lupus, treatment was given with a tube that sent its energy four inches within the skull. The exposures were made through a lead covering exposing only the diseased parts at a time, in order to save the remaining hair the patient had. A peculiar mental state developed following the treatment, with meningitis and death. A post mortem examination demonstrated that an area of atrophy had taken place opposite the five lupus patches, and at the triangle a marked inflamation was present, while one section showed marked X-ray changes. It is evident that the apex of the triangle was receiving twice the amount of exposure than was being received by each patch. These facts should be kept well in mind, in order to avoid too much exposure of deep structures.

Fatal Toxemia—Many of the old operators will remember the experience they had while treating a deep seated cancer. It was evident that a slow but steady progress was being made towards a recovery; when without any warning a sudden and fatal toxemia would set in killing

the patient in twenty-four hours. The cause of this trouble was a mystery for several years and was supposed to be due to the carcinomatous tissue breaking down, but is now known that it was due to the destruction of the normal cells beneath the surface.

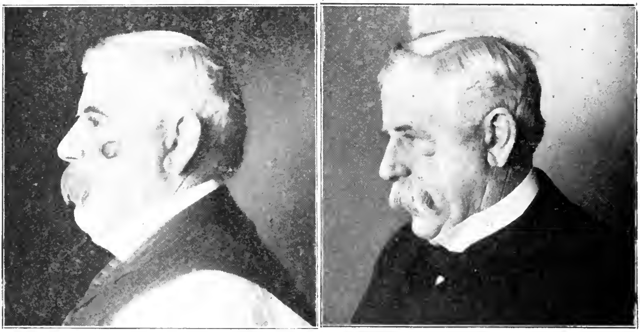
It is not possible to accomplish this result by hit or miss methods. This can only be done by carefully calculating the depth the ray should go, then regulating our apparatus with this result in view. In other words, we can produce an X-ray burn among the internal organs without influencing the skin in the slightest degree. The result is brought about by placing our tube at a greater distance, usually 18 inches for six inches of penetration, and compensating for our loss of energy by using more amperage in the tube.

CARCINOMA.

It is with reluctance that I mention this topic, but it has been considered as the most important one in connection with X-ray treatment, and the final word cannot be said as to its real value. There are many reasons why it is not possible to give a clear analysis on this subject at the present time. The most important is the belief among physicians that nothing has, or can have, a favorable effect upon cancer. The average medical man has had it borne in upon him so forcibly in his experience, that we know no method of treating cancer, and personally he dreads the disease so much, that he has responded to the call of the surgeon to send them in early, and no matter how early he sends them, he should have found them earlier in order to prevent a recurrence after operation.

Surgery in Cancer—The results from surgery have been, and are, disappointing; and when X-ray operators began to see some possibility of the ray proving useful, surgeons hailed the new treament, and promptly unloaded all of the cases which in their judgment were inoperable, or had had several operations and a recurrence too extensive for any more surgical intervention.

These cases were treated by X-ray operators without charge in the interest of the new science. While the mortality was frightful, a saving clause was found, and a small number of apparently hopeless cases did get well and have remained so for several years. It was regarded as almost criminal for an operator to treat a case that could be oper-



EPITHELIOMA OF FACE. 10 YEARS STANDING. SAME CASE AFTER EIGHT WEEKS TREATMENT WITH X-RAY.

ated upon with even a remote suspicion that it was operable; but as the ray slowly and laboriously found its usefulness in this disease, it was proposed that an operation should be done and the surface rayed afterwards as a safe measure. It worked well in practice. The surgeon took all of the patient's available cash for the operation, and the X-ray operator treated the patient in the interest of science. The increasing number of favorable cases, however, attracted the attention of a few strong-minded physicians and their cases were brought directly to the laboratory before operation, and treatment insisted upon. Only 48 cases of this character have been brought to my laboratory in the last eight years, all of these were very favorable cases, many of them among young girls with breast cancer, some with extensive glandular involvement, and only five deaths have taken place among that number. A few have a lump barely perceptible where the cancer was lo-

cated, and the glands have disappeared. Some of these cases are of ten years' standing and have shown no signs of recurrence, however, each and every one of them are fearful of recurrence, in fact, unthinking physicians who meet them encourage them in this belief.

*The five unfavorable cases were rapidly growing breast carcinoma, one with the glands in the mediastinum involved and metastases in the liver. She was under treatment for four weeks and was encouraged to have an operation to which she consented. The breast and glands were removed but a recurrence took place, and in six months proved fatal. A post mortem revealed that there was a general metastasis. The other case was under treatment for three months, and while her health and strength improved the breast cancer remained in about the same condition, not growing or showing the slightest sign of disappearing. She lived two years and died with pneumonia. No change could be seen up to the time of death.

The third case was a rapidly growing breast cancer, the ray seemed to have no effect upon its growth. She developed a peculiar cachexia a few weeks after coming for treatment, and died very suddenly. The other two cases were uterine cases, with a variable history under X-radiation, but death claimed both from cancer eventually It is only fair to say that these last cases were under treatment while we were suffering from a tube famine, and the proper tubes were not available. From the small number of primary cases that I have personally treated, it would not be fair to draw any fast conclusions. It can be said in passing that every case of the 48 noted was considered a favorable one from a surgical standpoint, yet not one of them could be persuaded to have an operation, so by considering the results carefully and comparing them with the known results following surgery the effect upon these cancers by this treatment must be considered favorable; and if time and experience of other operators confirm

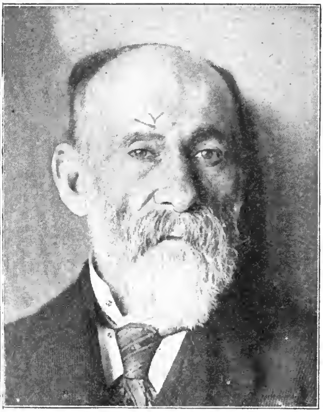
* Seventeen have died from recurrence up to date.

the value of the treatment, as seems likely, a great advance will have been made in medicine.

Recurrent Cancer—The majority of cases treated by X-ray operators make up the class showing recurrence after operation. Of these I have had many cases, involving all parts of the body and have had curious results. I have come to the conclusion that a recurrence following a breast amputation, if taken early, will almost always recover. The parts must be treated promptly and vigorously, and it is no uncommon thing to see a recurrence disappear after a severe dermatitis leaving no evidence behind, and a good chance of being immune.

Cancer of the Uterus—Many cases have been reported where this disease has been treated with the X-ray, some have been considered favorable, a cure seemingly taking

EPITHELIOMA 20 YEARS STANDING



SAME CASE AFTER 6 WEEKS X-RAY TREATMENT

place, while the greater number have turned out as failures as far as a cure is concerned. All of these cases come to the X-ray operator with an inoperable cancer, or an extensive recurrence following an operation, so it is not surprising that the results have not been better, as the

X-ray office has been the dumping ground of all the surgical clinics. As soon as a patient was absolutely beyond hope, and became a nuisance around the office he was encouraged to visit the X-ray man with some encouragment of good results. The result has been that our laboratories have been filled with patients who had no earthly chance to recover, and no one has ever had the delusion that they ever would. This condition has had more to do with throwing discredit upon the X-ray treatment than all other factors combined, and their treatment can only be justified because their life was prolonged, and rendered more comfortable because of the treatment received. I have never treated a case of uterine cancer by the ray, but what the patient showed distinct improvement, even if it was only a matter of a few weeks. We find that the hemorrhage will cease after about six treatments, the odor and discharge disappear, while granulations will follow in the course of three weeks. Many times the results look so favorable, and the general health improves so rapidly that both physician and patient are deluded into the belief that a cure will take place, but after a time the improvement seems to stop and the local conditions remain about the same for a period varying from two weeks to two years, but eventually a retrograde change is noticed, the ulcers slowly increasing in size, and a peculiar cachexia develops, the patient's health is gradually undermined and she dies suddenly, having been spared the exhaustion due to pain and hemorrhage. It is rarely necessary to give any opium in the latter part of their life, as death is usually a surprise to their immediate family, as they seem so jolly and care free and keep up their interest in life up to the last, although it must be evident to their friends that they are slowly failing every day.

Sometimes the operator is surprised to see the improvement continue, until no objective signs of the disease remain. Twice in my experience I have seen a cancer of the uterus the size of an orange which was ulcerating, and had all the marked symptoms of this disease,

diagnosis being confirmed by the microscope, cured. I was astonished by the rapid and complete disappearance of the disease, the patient regaining her health and strength, no recurrence taking place in five years. No hope was entertained in either case, and the treatment was undertaken as a palliative measure. Other operators have had the same experience, and are at as great loss to explain them as I am.

Technic in Uterine Cancer—The technic in two cases involved the use of a vaginal tube exhausted to Crook's

RECURRENT CANCER 12 WEEKS AFTER OPERATION
ALL ALONG LINE OF INCISION

vacuum, containing a cathode electrode of aluminum curved in such a way as to throw the cathode stream over a large expanse of glass, then connecting the cathode terminal to the high frequency coil, which resulted in a diffused X-ray near the end of the tube, that would penetrate the tissue for a distance of four inches, the bladder being protected by a layer of platinum foil placed over the active part to absorb the ray in this direction. Alternate treatments were given over the abdomen with a tube giving six inches penetration. I believe it would be possible to get a greater percentage of success if we had the proper

tubes to work with. I believe that the tube must be in close contact with the surface when we are dealing with a case of cancer complicating a mucous surface in order to utilize the Alpha ray. This ray is destructive of cancerous tissue, but as it has so little penetrating power it is necessary to modify our technic in order to get as close to the disease as possible.

The Beta ray will hinder and retard the growth of cancerous tissue, but rarely will cause its destruction. It is for this reason that I believe that a proper tube excited by an Oudon resonator connected to the negative pole alone will be more likely to prove useful in uterine cancer than any other procedure we have. The small volume of current does not heat the glass beyond a comfortable temperature, and the induction from the tube is not so unpleasant as we get from our regular type of apparatus. More investigation should be carried out with apparatus of this construction, actuated by a resonator instead of an X-ray coil. A wonderful improvement in the treatment of cancer has taken place within the last three years, that have improved our prognosis wonderfully. Metallic Zinc ions are driven carefully within the cancer with the electric current, care being taken not to use enough to disintegrate the tissue. Since using this method I have had seemingly perfect success in eight cases that did not offer a favorable prognosis. The use of Injectio Trypsin has also been a contributing factor to the favorable results. In certain cases the injection of the corpuscles obtained by Rodin's process, has given unlooked for results in the way it favorably influenced the course of the disease. Many reports of the favorable action of the ray upon uterine cancer have been recorded, one a recurrence after an hysterectomy, is reported by Dr. Wm. Pusey in the Journal of A. M. A., May 13, 1905. The recurrence had attained the size of a walnut, which was ulcerating and bleeding, but in three weeks under the X-ray treatment it had flattened down and there only remained an ulcer the size of a ten cent piece, in two months this had healed

and left a healthy scar. She has remained well for ten months, is healthy looking and now weighs 175 pounds.

Two cases were reported by Dr. G. F. Pfahler of Philadelphia, without details, at the Roentgen Society, of carcinoma of the uterus as apparently cured, four as retarded and one as improved.

Dr. J. N. Scott, Kansas City, Mo., reported at the Roentgen Ray Society, 1905, two successful cases of uterine cancer, and fourteen failures. A successful case of carcinoma of the uterus was reported by Dr. May Cushman Rice, in the New Albany Medical Herald,September, 1903. The patient had had a currettement followed by cauterization and was given X-ray treatment by Dr. Emil Grubbe for a short time through the abdomen. She gained in weight and felt better, but the discharge remained about the same. During December she had a severe hemorrhage, which continued at intervals until January when she became so discouraged that she stopped treatment, and in March she was referred to Dr. Rice. At this time she had fever, pains, night sweats, with loss of strength and flesh, accompanied with a good deal of sloughing off of tissue. Examination revealed a solid mass in the vagina with a much excavated cervix, none of the organs could be outlined, and the examination was followed by profuse bleeding.

Exposures were made daily through a Ferguson speculum of small size, a medium tube was used and excited by a static machine, lead foil was used temporarily to protect the surrounding tissue, but was soon abandoned as the area was so extensive. The pain was much relieved by the second treatment, and there was a marked and steady decrease in the discharge and odor. Treatment was given daily until August 29th, through the speculum, and from then on by alternate days through speculum and abdomen, eventually a dermatitis developed over the abdomen and buttocks, but at the end of the week had apparently subsided, when suddenly it took on a serious form and large blisters appeared over the parts. The

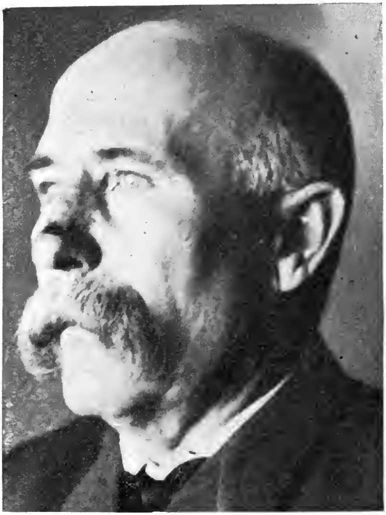
burns were not entirely healed until October 28th. October 31st, five weeks after the last treatment, a high temperature developed with a profound general depression. The temperature remained at 104 to 105 degrees for several days, severe chills followed, and the offensive discharge which had been absent during the treatment became very profuse. Coincident with this discharge the temperature became normal and a normal convalescence took place.

Many more cases have been reported of successful efforts in uterine cancer, but no useful purpose would be served by repeating all of them, more unsuccessful cases have been reported, which it is not necessary to announce at this time. It is sufficient to say that the treatment is on trial, and farther than that, it has not had a fair trial.

It must be evident to all readers that some operators have by a happy combination of apparatus and technic, or by a blunder, attained a result wholly at variance with our belief and education, a result that cannot be verified by other operators, or by farther work on their own part. The fact that these results have been brought about in some of the most hopeless kinds of cases shows one thing plainly, and that is that the X-ray has a specific effect upon the cancer cell, and that it will take years of hard study to find out what this effect may be. It is my conception that the X-ray prevents the embryonic cells from dividing. The next problem will consist in devising some method that will give just the right ray and deliver this ray at just the place where we want the work done.

At present no rational technic has been in use, we have been using the rays from all kinds of tubes and apparatuses. It is my belief that eventually a tube will be made of some glass composition that will give us just what we want for these deep seated cases, in other words will give us a ray that will penetrate to a known depth and not irritate the skin in passing. This can be obtained by changing the construction of our tubes in such a way that we obtain a flat field instead of the curved field in use at the present time.

I have spent a great deal of time and money upon this problem with results that encourage further investigation along this line. It has been thoroughly investigated by Mr. Robert Friedlander, who had the proper facilities to get results. The X-ray world owes this gentleman a debt of gratitude it will be hard



EPITHELIOMA OF NOSE.

to repay; he has spent his time, energy and money, in organizing, developing and manufacturing anything that may be of use in this line of work. He has one of the largest tube plants in this country, and has kindly constructed hundreds of expensive tubes, in order to prove the conceptions of various men to be true and false. It is to his own labor that X-ray workers have been able to get reliable tubes in the past, and it is with regret that we learn of his retirement from a business in which he has done so much for the medical profession.

Treatment of Internal Cancer by the X-Rays—At a meeting of the French Academy of Medicine, held on June 14, Doumer and Lemoine described the technique employed in the treatment of twenty cases of tumor of the stomach. As the results of treatment they claimed three complete and permanent cures. A fourth patient was well on the way to recovery. In a fifth case improvement at the commencement was rapid, and the tumor had disappeared when a relapse occurred, which, unfortunately, was not submitted to further treatment by the rays. In the remaining cases treatment was attended by a varying degree of success. The case that best exemplified the good results of treatment was a female whose case was reported in April, 1903. She still continued in excellent health, had had no relapses, and was perfectly free from the troublesome symptoms, as vomiting, melaena, icterus, etc., by which she had been previously tormented. The tumor, which at the first sitting was the size of a hen's egg, disappeared completely after seven exposures. In the majority of cases the diagnosis of cancer was arrived at from a careful consideration of the signs and symptoms — presence of tumor, emaciation, dyspepsia, emesis, gastric pain, and hemorrhage. A complete disappearance of the tumor, or an equally remarkable reduction in its bulk with a corresponding amelioration of the functional disturbances arising therefrom, was the harbinger of success.—Archives Roentgen Ray, '04.

X-RAY BURNS.

This important subject needs considerable attention at the present time owing to the increasing number of cases that are occurring among the new operators who are appearing in the field. It was known as early as 1896 that the X-ray was capable of bringing about a condition in the human body that might be dangerous, and considerable speculation was indulged in by the different physicists to account for the phenomenon.

W. M. Stine in the Electrical Review, Nov. 18, 1896, claimed that the burns were not due to the X-rays, but to the ultra-violet light emitted from an excited tube. Elihu Thomson in the same paper, of Nov. 25, 1896, gave it as his opinion that the effects were not electro-static as alleged, but were due to the chemical activity of the ray alone, and later in the American X-Ray Journal, of Nov., 1898, it was stated that burns were produced by the X-ray, and chiefly by those rays given off from a soft tube.

Theories of X-Ray Burns—Tesla, Electrical Review, of Dec. 2, 1896, claimed that the X-rays did not produce burns, but that this phenomenon was due to the ozone or nitrous acid generated upon the skin, and suggested that a grounded wire screen would prevent the trouble.

Rollins, Electrical Review, Jan. 5, 1898, exposed his hand to a tube of so high resistance that the current could not pass through it and still produced a burn.

Throwbridge, in the American Journal of Science, 1898, claimed that an X-ray burn was due to electrification, and that this condition could be produced either with or without the X-rays, and he exposed his hand to a brush discharge of a generator and produced a typical X-ray burn.

Time seems to bear out Professor Thomson's theory and is now generally accepted by all workers in the field. It is, of course, known that a static or high potential current when directed upon the surface of the skin is capable of producing a violent erythema and possibly a blister; but the readiness with which it heals shows that it differs radically from an X-ray burn. It frequently appears and disappears just as readily. Acute X-ray burns may appear in all stages according to the amount of dosage and the care the surface has received.

DERMATITIS.

This is a condition of the skin that appears in from 4 to 24 days, after it has received one or more X-radiations and its effect is directly proportioned to the amount

of ray received. We first notice a slight pouting of the follicles appearing like minute red dots upon the skin, followed in 24 hours by a peculiar itching sensation that gradually grows worse until it takes on a distinct smart; by this time the skin is noticed to be slightly swollen and the sensation has increased to a disagreeable burning, followed by neuralgic pains radiating away from the spot; the redness gradually increases with an increase in the thickness of the skin which gives a hard leathery sensation to the touch resembling a bad case of erysipelas. In the course of five days a distinct leaden cast is given to the red and it looks distinctly angry, and in the majority of cases it will remain in this condition for about five days, and then gradually begin to fade out from the edges towards the center. The application of any irritating substance or inoculation by means of the finger nails immediately turns the dermatitis into a destructive X-ray burn. Where this occus a large blister forms in the center and numerous smaller ones in the immediate vicinity, the pain increases in intensity until the victim is in agony, and there are few things that we have found that will give relief, even morphine has been found wanting, requiring almost poisonous doses before any comfort can be had. In some cases the slough extends below the skin for a distance of one inch and the pain and general prostration continue until it has completely separated. Regeneration is extremely slow, the surface refusing to tolerate any ordinary surgical dressing and immediately assumes a grave form if any of the irritating applications are applied, as, iodoform, boric acid, or any of the liquid antiseptics.

CHRONIC BURNS.

This condition is brought about by prolonged intermittent exposures to the ray, and X-ray operators, salesmen, mechanicians, etc., seem to be the only sufferers, especially upon their hands, owing to the excessive use of the fluoroscope, and occasionally upon the feet where the operators make a practice of placing the tube under the

table in order to examine the body while lying upon the table. Several serious burns have been received in this way making cripples of the operators for life. This condition is brought about by repeated mild attacks of dermatitis, until eventually the capillaries are destroyed and the nutrition of the skin and its appendages is seriously interfered with. We have a dry husky skin rather inclined to redness having a peculiar glazed appearance with a tendency to crack in places, the nails shrink and become distorted and eventually shallow ulcers form and a stinging burning sensation is continually present. In a few cases the process has extended far enough to destroy the usefulness of the member, and in several well known cases the degeneration has proceeded to the point where malignant conditions have developed necessitating the amputation of the limb.

Belated Burns—A surprise was in store for a few X-ray operators when they made the discovery that the X-ray treatment might lay the foundation for a destructive process that would require months or years to culminate, and we all recall the sad case of an English physician, Dr. Blacker, who suffered a severe burn of one of his fingers while manipulating his apparatus. This irritation produced an unyielding dermatitis which rapidly spread up the arm and in a short time cancer appeared in the skin at the elbow with glandular involvement in the axilla which followed almost simultaneously, and finally involved the entire shoulder precluding the chance of help by operating. We are also familiar with the case that occurred in the practice of Rubel where death followed an extensive burn upon the abdomen. Another case that has become well known was the assistant of Edison. This young gentleman in endeavoring to commercialize the X-ray apparatus used the fluoroscope without sufficient caution and eventually set up a process that made it necessary to amputate his arm. Cases like this can be multiplied indefinately and have happened among demonstrators of this kind of apparatus and among the users of the fluoroscope.

A case that was brought to my attention happened in the beginning of X-ray work to one of the best known X-ray operators. This gentleman became infected with the X-ray enthusiasm, and after purchasing a machine that the manufacturer guaranteed "not to burn" he persuaded his "fool friend" the barber to become the subject of the experimental work, and an attempt was made to take a skiagraph of the ankle joint, and after a number of failures it was given up for several weeks. Before it was resumed, however, it was apparent that something was wrong with the ankle. It was red and inflamed, while blisters covered the surface. Everything was done that could be to relieve the suffering of this patient, but the process extended until eventually the bones were bare and nothing would make granulations grow in the wound. An amputation was refused and eventually the bone was chiseled into by a surgeon and much to his surprise no blood vessels were found; the bone had the appearance of being petrosed and responded to the cutting instrument like the petrous portion of the temporal bone. It is ten years since this happened and the ankle still has open ulcers. This case had approximately 45 minutes' exposure on successive days giving from five to eight minutes each day according to the operator's side of the case, and from the patient's side the exposures varied from five to thirty minutes daily. The exposures were given with a 16 plate static machine. We are all familiar with the case of burn that happened in an eastern city. The physician purchased a static machine from a manufacturer who guaranteed it not to burn, and in this case the operator experimented upon himself trying to make a skiagraph of the shoulder. History tells us that the doctor did not get a skiagraph of the shoulder but did receive a destructive X-ray burn that crippled him for life. He brought a suit against the manufacturers and as the reports have it, recovered a judgment for $6,000. It is not known what effect this verdict has had upon future guarantees by this particular firm. If physicians would ask

questions from others engaged in this work instead of taking any improbable story that a salesman might tell, who is anxious to make a sale, such accidents would not occur.

I had my attention called to another deplorable case that is now pending in court. This was a saloon keeper who having an eruption upon his hands submitted to X-ray treatment, and as usual testimony differs, the physician stating that he had placed the tube seven inches from the hands and the man claiming that he had lifted his hands off from the table and had kept them in contact with the tube, as he could see no reason why he should not do it, although he acknowledged that he was told to keep them away from the tube or he would be burned. He is supposed to have had seven treatments of five minutes each, after which he complained of an itching sensation and the doctor stopped treatment immediately and told him that it would be advisable to wait for a few days in order to see what the results would be. This is the last time the operator saw the patient for one year, but the subsequent history was given in the testimony in court. About ten days after he had stopped treatment a violent erythema broke out and as the pain and itching were so severe another physician was called in who dressed it with a strong carbolized solution and covered it with rubber protective; the next day the sloughing process began and he dusted it with iodoform, which was used for several weeks. The process continued and the man almost went insane with the pain; other physicians were called in and nearly every drug that surgeons use was tried in succession, both to relieve the maddening pain and arrest the destructive process. Little success was achieved in either direction, and eventually it was necessary to excise many of the tendons that had sloughed before any relief could be obtained, after which a slow reparative process set in. Prolonged soaking in warm saline solution eventually caused granulations to take place covering the surface with a very sensitive skin which was non-elastic, this with the loss of tendons and the contracted fingers has effectu-

ally made a cripple of this man. I had the opportunity of examining the hand when it was presented in court and I must say that it lacked many of the characteristic appearances of a typical X-ray burn; that in this case at least the X-ray was only a contributing factor, while the irrational treatment that was adopted by the attending physicians in their desperation brought about the extensive destruction that was evident in the result. Of course, it should not be necessary to add that a little petty spiteful sentiment so often found in small places was the cause of the present humiliation that is shared equally among them at present, and it is impossible to say just who is responsible for his condition. It is also among the possibilities that stale beer may have added its yeast germs to the soil that was thoroughly prepared for them as he attempted to attend bar after the sloughing process began, and we all know the destruction that can be wrought in the human tissue by a mycotic infection. If a lesson is to be learned from this case it is this, that physicians at large should let an X-ray burn severely alone and let the individual who produced it handle it without any help; it will make him careful the next time to see to it that he does not produce another, and presumably he knows the best method of handling this trouble. As for his medical brother who takes the case off his hands, he has only sorrow and humiliation as his portion, with plenty of hard work and very little money, and now days it is certain that he must waste much of his time attending court while the latter is trying to find out whether it was the X-ray, iodoform, or mycotic infection that has brought about the terrible destruction. It is robbed, however, of its humorous features when a man in vigorous health suddenly becomes helpless as a result of crippling of his hands.

Instances of this kind can be multiplied by the hundreds by referring to my files but no useful purpose would be served, and many cases are more pathetic than the one related above, and many are not of such a serious char-

acter. A number of very late burns have accumulated and have been reported by different operators.

Belated Burns—Two of these cases were reported by Clarence E. Skinner, M. D., before the American Roentgen Ray Society. The first case was a woman 50 years of age, of the brunette type, who was under treatment for pseudo-leukemia accompanied by a large collection of fluid in the abdomen. The glandular enlargements were very prominent in the abdominal cavity, especially upon the left side and in the cervical, axillary, and the vaginal regions. The X-ray applications were all made over the abdomen, and the tube focused about two inches to the left of the median line, but so arranged that all regions affected would receive some radiation; no shield was used except over the face and only a thin towel was interposed between the skin and the source of light. The tubes used were of the German type with divided anodes, forcing back a spark of from 4 to 8 inches and producing rays of a high penetration. The distance of the anode from the skin was ten inches and the time of exposure fifteen minutes.

The apparatus used was a 12 revolving 32-inch plate, Wimshust-Holtz machine for the first three months and a 16 plate machine of the same type afterwards.

From July 26, 1902, to Dec. 4, 1902, she received 50 X-ray treatments, being an average of one every 2.6 days. From Dec. 4, 1902, to April 3, 1903, she had 25 treatments or on an average of one every 4.7 days. By this time the disease had improved to such an extent that it was considered safe to stop the treatment for a time which was done. During the time she was under treatment the abdomen had become heavily pigmented and peeled off exposing a pink, healthy skin underneath. Twice there appeared a slight erythema with itching and burning which subsided completely in five or six days after treatment was stopped. On April 30 she was found to be suffering severely with sharp cutting pains in the anterior abdominal wall and extending up under the ribs nearly

to the shoulders upon both sides. The skin of the abdomen had been darkly pigmented but showed a dark redness through the brown over an area of about six inches in the vertical and ten in the lateral diameters, and a very intense burning sensation was torturing her constantly. Various ointments were applied without relief, and it became necessary to resort to morphine in a day or two. The condition progressed from bad to worse and by May 13th an area 4 by 8 inches presented a typical picture of white gangrene, the dead tissue being yellowish white in color, of a tough leathery nature and contained the characteristic gangrene odor, severe shooting pains were present constantly and manipulations of the parts produced paroxysms of pain lasting several minutes; the pulse ran from 105 to 115 beats per minute, and the temperature from 100° F. to 102° F. and the patient was so prostrated that she was unable to leave her bed, her appetite was excellent and remained so through the entire course of her illness.

Treatment—Dressings were made with normal saline solutions followed by a ten per cent aristol and lanolin ointment twice daily. At this time the edges of the slough began to separate and this process progressed steadily until June 9th, when it was completed by the exfoliation of the central mass which was three-fourths of an inch thick. Synchronously with the completion of the sloughing process the shooting pains also ceased. The healing process was hastened by using the galvanic current with from 5 to 10 milliamperes for ten minutes for three times a week, bring the negative pole in direct contact with the ulcer. By October, 1903, the ulcer was covered with a healthy skin.

The second case was a patient who was a medium blond with grey eyes and dark brown hair, age 49. Came for X-ray treatment for an inoperable malignant process in the neighborhood of the left broad ligament accompanied by marked ascites. From Jan. 27, 1903, to April 4, 1903, she received 115 treatments, an average of one

every 3.7 days. The technic was the same as was used in the first case, except that the 12 plate machine was used on this patient for nine months, and her improvement was such that it was considered safe to stop treatment for the time being and await results. As in the other case the skin became darkly pigmented during treatment and peeled off showing a healthy pink below. Three times a slight erythema, with itching and burning, was produced but subsided kindly when treatment was suspended. There was nothing apparently in the condition to indicate possible trouble when the treatment was discontinued but there was present at this time a phenomenon that I have never before observed in this connection, consisting of a subcutaneous effusion of blood as large as a nickle. This area was slightly depressed below the surface of the secondary tissue, was sensitive to the touch, and had developed suddenly two or three days before. The spot became more sensitive daily and sharp pains appeared in this region, which radiated upwards towards the ribs and increased in severity until May 1, when it was necessary to administer opiates. The area became gangrenous and the temperature increased from 99° F. to 101° F., while the pulse ran from 95 to 105 per minute. The necrotic area increased until by the middle of May it was the size of a silver dollar. About the same time a hemorrhagic area appeared upon the other side of the median line of about the same size which became necrotic about the first of June.

By the first of July these areas had coalesced at their lower borders through an isthmus three-fourths of an inch in width, the necrosis being preceded by subcutaneous effusions of blood; the tissue was tough and had a bad odor. The long continued severe pain made her removal to a sanatarium imperative, where she could have better attention, while we ran through the list of sedative drugs looking for something to relieve her, when finally we decided to try a mixture of lanolin, olive oil, with powdered opium, supplemented with an ice bag which gave her

enough relief to make the pain bearable. The application of the above with a saline irrigation was the procedure finally adopted.

The galvanic current was tried, but had to be abandoned as the ulcer was so sensitive that the slightest irritation made it unendurable. The sloughing process proceeded slowly and was not complete until October, but the disappearance was, as in the last case, followed by the complete absence of pain. The ulcer was completely healed by the last of November.

Personal Case—A case of my own occurred in a young lady with a carcinoma of the breast with extensive glandular involvement. It was an extremely unfavorable case when she presented herself, but the treatment was undertaken in the hope that something could be done. She received 90 treatments in four months, which resulted in a gain of eight pounds and a total disappearance of the cancer and glands. The most careful examination failed to show any signs of irritation; the skin was well tanned when she left for her vacation in June. She returned the first week in September and came in for an examination and everything was found to be all right; ten days after she called again in great excitement and told me that the former site of the cancer had caused her so much pain that she could not sleep. Upon examination a dark discoloration from a subcutaneous effusion of blood was seen and trouble was immediately suspected. It was deemed best, however, to wait for a few days in order to see how far the process was likely to extend. The pain increased in severity and the prostration was remarkable and in a few days unmistakable evidence of gangrene were present. She was losing so rapidly that I determined to put her into the hospital where I could operate upon her at a moment's notice. She remained a week in the hospital when her condition became so grave that I operated at once. She was anesthetized and I carefully separated the necrotic area with a pair of scissors and scraped the base of the wound vigorously with a curette and was surprised

to find no hemorrhage, and a hard glistening fibrous base was found below the ulcer. After thoroughly sterilizing the wound I took a knife, going beyond the hard area I cut a cup shaped disc of hard fibrous tissue in which many sections were made without discovering the presence of a blood vessel. I removed every shred of the hard tissue and left only normal tissue. When she awakened she did not complain of any pain and the wound granulated like any other healthy wound, and in six weeks she had completely recovered and went back to her occupation of teaching school and has had no recurrence in six years. A great number of these cases of delayed burns have accumulated, many of them not being reported in the journals, their presence being known only by correspondence.

Treatment—This important subject has never received the consideration it deserves owing to the lack of experience of the operators. As a general rule each man does not get more than one or two cases at most before he begins to use extreme care to avoid repetition of the trouble, and his experience with any one case is not of much value, although going far to help us make up our minds as to the best way to handle a case when we have one. The best way will always be found to avoid them as far as possible, or, at least try and confine them to the dermatitis stage, which can usually be done if the patient can be persuaded to expose the burn to the air. Nature throws out a protecting coating of a gummy viscid character that serves the purpose in an admirable way as a dressing, and when it becomes too thick it can be removed by soaking in hot water for a few minutes. No soluble powder or chemical or any irritating application must be used under any circumstances, as they are all followed by a very destructive dermatitis that may reach the third degree or an extensive destruction of deep tissue. The only applications that I have found that would be tolerated are stearate of zinc, talcum powder (plain), and bismuth subgallate.

Danger in Petrolatum—Petrolatum preparations are extremely dangerous to all of the tissue. Many of these

preparations are strongly acid or alkaline as the case may be and will blister an X-rayed surface within 24 hours.

Surgical Treatment—Extreme pain, prostration and a slight discoloration are indications for an operation, and the sooner the surface is removed down to a depth where it is well supplied with blood the better for all concerned; immediately the pain is relieved and the general health improves and we have only an ordinary wound to treat, cicatrization is prompt. In eight cases where I have advised it in consultation the results have been perfect.

Where a chronic burn exists as upon the hands of X-ray operators the fissures and cracks should be removed deeply, if a prolonged treatment in hot normal salt solution applied with gauze and compressed with a rubber bandage, does not bring about regeneration, prolonging the treatment for several weeks. The treatment will frequently save a pair of hands that appear hopeless.

Roentgen operators should try to the best of their ability to educate general practitioners and surgeons that an X-ray burn is different from any other thing known in medicine, and for that reason requires a different treatment than they have been using in their practice.

CAUSE OF X-RAY BURN.

As indicated in the beginning of this article a number of theories have been advanced to account for this strange phenomenon, found only in rayed surfaces; but it is not necessary to discuss many of them, as time and experiments have proved them without foundation, and I think it is safe to accept Prof. Thomson's theory that they are due to the X-ray and to that alone. This does not exclude the fact that a dermatitis may follow an excessive amount of induction from a static machine, high frequency current, or an X-ray tube; but this fact is noted that a burn from the latter cause is not an X-ray burn, does not act like one, and will not react to chemical irritants like an X-rayed surface, and has never been known to destroy tissue like an X-ray burn.

Biologic Effect of Ray—A great amount of time and experiment have been given to this subject by all departments of medicine, and enough facts are now known to justify the belief that the X-ray has a peculiar biologic function, in other words the X-ray brings about a peculiar condition within the cell depriving it of its power of division. Numerous experiments have been made by means of the protozoa, and it has been found that the growth of the colonies can be controlled completely according to the amount of ray they absorb, in other words a colony of the protozoa in favorable surroundings may live through 275 generations before they lose their vigor of reproduction and require stimulating by means of some chemical, as magnesium sulphate or sodium chloride, and then they may again go through as many generations as before. It is curious that the protozoa do not seem to respond to chemical stimulation after a certain amount of the ray is absorbed, and may die out in as few as 20 generations regardless of all efforts to save them.

These experiments give us a working hypothesis so that we can get an intelligent grasp upon this difficult subject. The body cells are made up of the protozoa in masses, and the life history of the body cell is very little different from the free protozoan, and it is not too much to believe that they would respond to favorable or unfavorable stimuli in practically the same manner. Now if the ray destroys or disturbs the vegetative functions of the cell, it is easy to account for the known and bad effects of the ray.

Biologic Effect in Cancer—In cancer we have an embryonic cell undergoing a stimulation from some unknown source, and the tumor attains a great size before we realize that anything serious has taken place, but when we use the X-ray upon the cells we inhibit their vegetative function; reproduction is inhibited or destroyed with the result that we have a retrograde process, and a cure can and does take place.

If we push the amount of ray beyond the inhibiting point we get a complete cessation of the reproductive function and the cells die, or are enfeebled to such an extent that the slightest unfavorable environment is followed by death, and extreme destruction takes place, and we have what is known as an X-ray burn.

The use of salt solution is justified by reason of its known function. Salt imparts new vigor to a debilitated culture of protozoa, practically giving a colony a new lease of life for a great many generations, and for this reason a prolonged bath of normal salt solution will impart a new vigor to these cells that have not been entirely deprived of their power of division. It is apparent that the use of any chemical might cause the death of these cells while they are suffering from the debility produced by the ray, and farther that the destructive effect might extend for quite a distance into the apparently sound tissue. If it is apparent that a large area is suffering from the ray and that reproduction is suspended or destroyed a wide and deep operation should be made in order to reach cells that have their reproductive functions unchanged. Where this is done the X-ray burn will lose its terrors and will offer no more trouble in cicatrization than any other wound. The principal difficulty with the management of these burns in the past has been the lack of knowledge among the operators concerning surgical procedures. A prompt operation will relieve all of the suffering and effect a rapid repair, and should invariably be undertaken early in the interest of both physician and patient, as months of agony are bound to leave an indelible mark upon the human mind, that nothing can efface. We must take in consideration also the possible effect upon the nervous system of large doses of narcotics, that are invariably necessary for the great pain and prostration. Several cases that were put under my care by other operators required treatment for the opium habit before I considered it safe to allow them to pass out of my hands, one individual with a bad burn upon the

abdomen, required five grains of morphine to a dose to say nothing of the immense amounts of whisky that he consumed, to make life worth living.

Pain—The pain from an X-ray burn is very characteristic. It has no other known analogue in medicine. We may have the smarting, itching, and radiating neuralgic pains for a few weeks, until it is evident that necrotic tissue is present, when the pain becomes an agony. The sufferer will rush about the room, tear his hair, throw himself upon the floor and roll from side to side, gritting his teeth. The eyeballs protrude, ideas are confused, while the perspiration falls from him in streams. It will last ordinarily as long as the gangrenous tissue is in the wound, and stop upon its removal.

After the wound is cleaned up by curettement relief from pains may last for a few days or weeks, eventually, a yellowish exudate forms upon the base of the ulcer, and the pains recur, with this variation. They are paroxysmal in character, coming on several times in twenty-four hours and lasting for an hour or more, when they leave as suddenly as they came. The patient is perfectly comfortable between the attacks, and feels as well as he does in general health.

Nothing but thorough and deep removal will give any relief. Every local application, even cocaine will nearly drive them wild, and it should never be used.

A new theory has been advanced by Albert Geyser, Radiographer at Cornell, that the destructive effects of the X-ray are due to ionization of the air between the tube and the patient, and can be avoided by bringing the tube in close contact with the tissue under treatment, by means of a special tube, which he calls the "**Cornell tube.**" This tube has its terminals bent back at an angle, in order to keep the connecting wires as far away from the patient as possible, and is made of lead glass, excepting the bottom of a cylinder which is of Bohemian glass opposite the target. He claims to have better therapeutic results from this tube, and in his experience no burns have re-

sulted. To prevent induction, he grounds the positive pole of his static machine.

It is more than possible that his good results have been due to his own skillful work and less to the tube. Still more investigation is required along this line, and it is possible the secret may be solved entirely. It is well to use caution, and not take other people's experience as final, owing to the different conditions which each worker must meet. There seems to be no question in the mind of any operator at the present time that the burn is produced by any other condition than the X-ray and by accepting this as a fact, and regulating our conduct accordingly, seems to be the only way to keep out of trouble.

The apparent immunity enjoyed by Dr. Geyser's patients may be due to many causes, but principally to the small amount of ray that the tube gives off. Many attempts have been made to construct a tube on this order, and the great majority have been fragile, and gave off so much induction with the coil, that patients could not be persuaded to stand it, and they had to be abandoned for this reason. If Dr. Geyser has been successful in overcoming this difficulty, the X-ray fraternity owes him a debt of gratitude it will take years to pay, as there is no one thing that acts so much like a nightmare to the X-ray man as the possibility of an idiosyncrasy in a given case. There are many reasons to believe that some people are particularly susceptible to the ray, and in my own person, a four minute exposure to a very mild radiation, is followed in about five days with a disagreeable itching sensation, that lasts for two weeks.

CALCULI.

The radiographer's ability to detect calculi in the kidney, ureter, bladder, and occasionally in the gall bladder, has been of incalculable value to medicine. By this means, we can not only make an accurate diagnosis of the location, but of its approximate size and shape. We are able by this means to find a stone or determine its absence,

and thereby prevent many unnecessary operations, where the symptoms may be quite characteristic of a stone being present.

I have had this question put up to me over a hundred times during the last 12 years, and as yet have never had my attention called to a failure.

Many surgeons have disregarded the negative evidence offered by the X-ray, and have operated only to be disappointed in finding a calculus present. Several misinterpretations of the negative have been made, a stone being shown that was assumed to be in a kidney, which upon operation was found as a calcareous deposit in the omentum and removed.

Many times the symptoms are so obscure that a diagnosis of appendicitis, cystitis, or tubal disease may readily be made, where the actual trouble is a calculus. The exact location of the stone preserves the patient from an exploratory operation, trying to locate what kidney the stone may be in—a condition of affairs that has been altogether too frequent in our operating rooms in the past, and one that has not entirely disappeared since the discovery of the X-ray.

It has always been a mystery why some surgeons will persist in disregarding the help to be given them by the X-ray, and affect to despise it as a method of diagnosis, proudly telling their classes that it is absolutely unreliable, when all intelligent physicians know that it is reliable, and if any mistake has occurred it is an individual mistake, and has nothing to do with the process. This individual's attitude has always been a great mystery to me. The bare mention of the X-ray before some surgeons has about the same effect as a red rag to a bull. They simply close their eyes and start in blindly tearing things up. They can't see any good in it, and if they had their way, would banish it from medicine.

These people have lost sight of one great fundamental truth; they are merely a factor in medicine, while the X-ray will endure forever. Truth is eternal and

may be obscured by sophistry for a time;—a barrel will cover an arc lamp and obscure its rays, but the rays are as bright inside as ever and will throw as much light when released as before. So with the X-ray, its wholesome truth will find its way, despite the opposition it has persistently met since the discovery.

It is conceivable that a case may exist where the X-ray, when rightly handled, might fail to find a stone. Many people seem to have muscles very rich in calcium, and in these cases an element of doubt might enter, and it would be the part of wisdom to call in other means to confirm a diagnosis in these cases.

The perfection of cystoscopy and the great skill attained by numerous physicians in catheterizing the ureter should always as far as possible be used to verify the findings in a given case. Many members of our profession are not aware of the marvelous skill with which lead catheters can be passed clear to the pelvis of the kidneys by these men, and by melting a little hard wax upon the end of their probe, no difficulty is experienced in getting the impression of a stone upon it.

People who weigh over 200 pounds offer much difficulty, especially if a pendulous abdomen is present, and require special methods to succeed. This can usually be done by using a compression diaphragm to approximate the abdominal wall and push its contents out of the way, and prevent motion during the exposure.

The literature has been enriched from several sources regarding the author's ability to see a calculus by means of the fluoroscope, and this has led many well meaning physicians to unnecessarily expose a patient, trying to make out a diagnosis by this method. It requires a good imagination to see things satisfactorily with a fluoroscope, especially if it is a calculus. These things may have been seen as described, but are regarded by regular operators as being most likely a defect in the crystals of the fluoroscope, or a case where an amateur operator has read into

the image his anxiety—a human failing to be carefully guarded against in the X-ray.

No reputable or experienced operator has ever claimed to be able to see stones with a fluoroscope, and not because they havn't tried under the most favorable circumstances. It is simply incredible that a stone would be visible under these conditions, and it should not be tried. Almost weekly, some patient comes to my laboratory for a skiagraph, who has been submitted to a prolonged seance with the fluoroscope, looking for impossible things, and a great injustice is done the laboratory, as so little a margin is left for a skiagraph, without the danger of a burn.

One case that happened last August:—A woman presented herself for a kidney plate, with the proper letter from a general practitioner. I was unable to make the exposure for three days, owing to a shortage of plates. When she came in again, a serious type of X-ray burn had developed, one that is not well today. The lucky escape of the author from being included in the damage suit, will be appreciated by others similarly placed. The woman had over one hour's exposure by different medical men, trying to find a calculus with the fluoroscope.

It cannot be impressed too strongly upon the physician that it is a profitless undertaking, trying to make a skiagraph of a calculus until he has mastered the details of X-ray work thoroughly. Those physicians who are always ambitious to begin at the top and despise the easy work, will never succeed. Only a skillful man can find these bodies with precision. They are the acme of success in skiagraphy.

No golden rule can be given that will enable everyone to do the work, owing to the great number of machines in the hands of the profession. Many of them are unsuitable and would tax even an expert to get a plate that he would be willing to stake his reputation upon.

Gallstones are rarely found with the skiagraph. A few successes are occasionally met with, but only in a

very thin class of people. The density of the gallstone is approximately the same as the bile, and while we have no difficulty in outlining the gall bladder, it is hard to differentiate stone from the shadow.

A serious source of error has been presented in some cases by the movement of the kidneys during respiration, destroying the sharp outline of the stone and introducing a diffuse shadow that may be interpreted as the kidney substance. It should be the aim to fix the abdominal contents by means of a sheet, pinned tightly, without wrinkles, over the abdomen and under the table. This limits respiration, and prevents any unnecessary motion of the contents of the abdomen.

No exposure should be made without the stomach and bowels being absolutely empty. In this way, we avoid the absorption of the ray, by the fluids in the stomach and hardened masses of feces in the bowels.

Technique—Kidney Stone—Have stomach and bowels empty, use a compression diaphragm or a binder to fix abdominal contents and to approximate the walls; reduce a tube to a parallel spark resistance of 3 inches, and use it in series with the machine. Place the tube in such a way that the ray will pass under the ribs, and use a mild current of about 1½ milliamperes for from 3 to 5 minutes, depending upon the size of the individual. Do not attempt to force the current beyond this amount, or a failure will be the result.

It is seldom that an instantaneous exposure will show a stone. The volume and intensity of the ray is so great that the stone does not absorb it, while by using less intensity, the stone will absorb its full amount and show up beautifully upon the plate.

With oxalate stone, the shadow is sharp and clear; occasionally, a urate stone gives a reverse shadow and to obviate this, we have occasionally injected the ureter and pelvis of the kidney with Oxygen gas. This procedure gives a clear definition, and the stone stands out clear.

Bladder Calculi—These are ordinarily easily found, by simply emptying the bladder, and using a compression diaphragm, but show better by filling the bladder with oxygen gas or sterile air. Many times residual urine has been mistaken for stone in people with prostatic trouble, so that a catheter should always be used to be sure nothing is in the bladder.

A source of error may be accidentally met with, as I learned to my cost: I found a large flat stone, presumably in the bladder. A supra pubic cystotomy failed to verify the diagnosis. The patient was an old man who had suffered for years with an enlarged prostate with cystitis.

The stone was found later at the autopsy. It seemed a perforating ulcer had formed between the bladder and rectum, and a huge flat pocket formed, which was filled with a flat concretion. This verified the X-ray, but did not save the operator from several days of humiliation, which was made the most of until the shoe was fitted to the other foot, when nothing more was heard about the matter.

As a general rule, a tube that will back up about 3½ inches is best for bladder cases. The anode should be placed parallel with the crest of the ilium, in order to drive our pencil of rays in the plane of the pelvis, and avoid superimposing the shadow of a stone on that of the coccyx.

Ureter Stone—As a general rule, we find these bodies at the mouth of the uretral orifice, close to the bladder, and if we are not careful, we may mistake the shadow for something else. It is well, however, if much doubt exists, to pass a uretral sound to verify the diagnosis, as we are compelled to get this shadow through the mass of the ilium, many times, as it is located so high we cannot throw it through the plane of the pelvis. The same tube used for bladder stone may be used for this purpose.

Gallstones—Where we succeed in getting an outline of the gall bladder, we must prepare carefully. The stom-

ach and the bowels must be empty, and the patient is placed upon the abdomen, the exposure being made through the back. The tube should back up about 2½ inches, and must not be forced. We must make up in time what we lose in intensity, and as long as 10 minutes can be given with about one milliampere of current running through the tube.

Development—The development of calculi plates is a fine art. The temperature of the developer must be maintained at about 60° Fahr.; we must dilute our developer at least one-half in strength, and carry the process for about 30 minutes.

Much finer results have been obtained by tank development. In this process, we dilute our developer about 20 times, and set the plate edgewise in a tank, and they are allowed to stay there for from 8 to 15 hours. This gives a wonderful value and clearness to the different densities of the soft tissue; many times the outlines of the bowels will be visible on our plate.

Interrupter—The best work can be done with the electrolytic interrupter, as this instrument gives the clearest pencil of rays, and is under perfect control, when properly made. The work can be done, however, with any type of apparatus by careful attention to details.

We should aim to get a negative that will show the process of the vertebra clearly, with a softness in the surrounding tissue, and where we have a plate of this character, we are able to say positively that no stone is present in the absence of a shadow. The correct interpretation of a plate is of the utmost importance, and can only be done by one with considerable experience in this line of work. A diagnosis must not be made by a wet plate. In every case the negative must be dry.

A number of operators have made a great success with the process, notably Boggs, Leonard, and Fuchs. All of these men have obtained success by following a different technique.

THE X-RAY EXPERT IN COURT.

The X-ray operator will soon be the most important expert appearing in court, if the present trend of legal presentment is followed.

The courts of all states are taking kindly to the skiagraph, owing to the fact that it offers something tangible for the jury to see. When the expert qualifies properly, no court will rule a skiagraph out, no matter how strenuously the opposing attorney may object. They are received with such favor that it is a serious question as to when a ruling is made holding it to be malpractice for a surgeon to fail to use the process as a guide in the treatment of a fracture.

Few people are satisfied with the result of a broken bone, no matter how good the apparent results may be from the surgeon's standpoint, and when they are presented with a bill calling for enough to buy a house and lot, and have only a painful union of a fracture to remember their experience, they are apt to ask the question seriously as to whether as much thought was given to attending the fracture as was given to the amount of the bill.

By telling their experience to their friends, their grievance begins to assume great proportions, some general practitioner is consulted, and a skiagraph is made that shows a serious want of consideration or lack of skill on the surgeon's part. A lawyer is brought into the case, and a situation created that is going to make it exceedingly disagreeable for everyone connected with the case.

How much longer skiagraphers will plead limitations to their art, in order to save some individual who is either too smart to require their services, or who affects to despise them until he is in serious trouble, is a question that the courts alone must decide. Already one precedent has been established by an English high court, denying surgeons the right to interpret a skiagraph, this being a function of the X-ray expert alone. They have gone

farther in the same decision and have conferred the title of X-ray expert upon electricians, physicians, druggists, etc., who are in the habit of doing this class of work.

Surgeons, through jealousy of other pratitioners, have brought into being a class of non-medical men to pass upon their own acts, and the end is not yet. A good paying business can be had by any individual who is willing to take up the work that regular medical X-ray laboratories are compelled to refuse in the general interest of the profession.

That some one has not done so up to the present time, is due only to a lack of knowledge of the great opportunity that offers.

Today, after about twelve years development of this beautiful process, not one percent of physicians use it as a means of diagnosis in fractures. This has had the effect of inciting a flood of damage suits all over the country. Dissatisfied patients have come into the city, and have had plates made at the metropolitan laboratories, at the request of their family physicians, who do not realize the gravity of the X-ray showing until it is too late.

The present trend of thought in the legal field is inclined to hold a surgeon responsible for a bad result in fracture. It is not to be expected that a mind trained in the law alone can conceive of the innumerable difficulties that present themselves to a surgeon in individual cases. It can excuse him, if he is in a position to prove that he has earnestly tried to do his duty by his patient. A judge and jury cannot understand why a man who has had a case of so grave a character to handle, as his bill would lead them to believe, did not take a skiagraph until the fracture was six months old, and gained knowledge that would have enabled him to avoid the disastrous results shown.

How much longer this individual can compel through medical organizations, the skiagrapher to stultify himself in his interest is an open question, but a spirit of resentment has been growing for some time that will

explode under some of the extreme provocations this man has to contend with.

The handwriting can be read on the wall, and interpreted means simply that in the very near future, every man who assumes to treat a fracture must stand or fall from his own pedestal. He will receive little consideration where he wilfully deludes himself with his extraordinary diagnostic ability in a given case.

The most reputable class of physicians and surgeons, as well as skiagraphers, are getting tired of stultifying themselves upon the witness stand getting an individual out of trouble, where he alone is responsible for his dilemma.

Preparation for Court—When an X-ray expert is called in court, it is well for him to study up upon the anatomy and physiology of the part, and, if possible, a section of the skeleton that shows the part under discussion. This enables him to explain the skiagraph to the jury in the simplest possible way. He should by all means avoid technical terms and elaborate details, and confine himself to the simple truth, without exaggeration. He should tell all that is known about his art, and be careful not to tell anything that is not known. He should in a simple way give the jury a grasp upon the actual pathology present, and treat the opposing lawyer with courtesy, giving direct answers where it is possible, qualifying either as may be necessary. His sole desire should be to make the case as simple as possible in order that the jury should not get an exaggerated idea of its importance.

He should call attention to the possibilities of errors, owing to faulty positions of the tube, and the magnification of parts far removed from the plate, and, as far as he can control the situation, explain the difficulties a fracture entails upon the surgeon in the case presented. A show of partisanship always defeats its object; a full, frank statement of the plate, its displacement, and the reasons why the conditions are as shown, will nearly always be allowed by the judge over the objection of both

attorneys. Just as long as you continue to give information that is intelligible, your testimony will be allowed. Speculation and theories are excluded. This kind of an expert is welcomed by judge and jury, and he is allowed great latitude by the upper courts.

In presenting an analysis of a skiagraph, the age of the individual should always be considered in order to have a working knowledge of the progress made in the different ossification centers, and to avoid the common error of mistaking an epiphysis for a fracture. Where possible, an exposure of the opposite side should be made, care being taken to get both plates at the same angle with the tube. This gives us a plate for comparison purposes that could rarely be disputed.

If several skiagraphs are offered, taken from a case at intervals, the shadows should be calipered in order to avoid substitution of plates.

The skiagrapher should understand the difficulty that would naturally present itself to the attending surgeon in a given case, and, as far as possible, accentuate them in his testimony, that the jury may appreciate the fact that the replacement of dislocations and fractures is not exactly an automatic process, and that further, each case presents difficulties all its own.

If the surgeon has earnestly tried to benfit his patient, he should not be punished for a bad result. What should be done with the individual who has let his indifference or spleen against a patient contribute to a bad result, is a question now rapidly approaching a solution.

The demand for a large sum of money at a vital period in the history of a case, and abandoning the case because it is not forthcoming, is not going to influence a jury favorably when the patient is compelled to call in another physician, as has been done in the past, as it will appear to them to be the only logical thing to do, and the motives of the first attendant will be considered carefully from a practical standpoint. Many decisions in late years by the supreme courts are favoring this view, and eventually

the proposition will be put fairly before the jury by some shrewd lawyer, and another precedent will be established that will mean considerable trouble for many members of our profession.

Heretofore, the court has assumed that the patient owes a duty to the physician, and the physician to the patient. In other words, the patient is supposed to consult no other physician without permission of the first, and the physician has an implied contract to give his best care to a case after he has once assumed charge of it, until the patient is restored to health or is an incurable invalid. In late years, both parties to this contract have shown a disposition to avoid its unwritten terms, and the time is ripe to change the precedent, and allow the patient the privilege of selecting what advisory talent he wishes, while the physician is to be held strictly to account for the result.

Philanthropy in Court—We have labored early and late to convince the courts of the land that our profession is essentially benevolent, and we have succeeded to such an extent that now they have great difficulty in seeing the financial side of a medical question.

We have always assumed that a patient was ours when we had once prescribed for them, and that he was in duty bound to get his future medical attention from us. The rapid increase of medical graduates turned out of our commercial medical colleges, have brought about a competition that is becoming more keen every year, and will turn over many of our established customs in the near future. The hope that the colleges will curtail the output is fallacious, owing to the fact that these institutions are now run for profit and the individual advertising of the men connected with them.

It is probable that we will even have a greater increase in the number of colleges rather than less, owing to the numerous medical men who desire the title of Professor. It is also probable that the so-called medical charities will increase enormously in the future to give the increasing

hordes of new graduates a chance to advertise themselves at the expense of their fellows, and all of these questions will bring about new medico-legal conditions that we must contend with. It will react against the individual physician; already the hospital is being dragged into court to explain how it happened, and its pleading of being a charitable organization by parading under a charity charter, has saved it in many cases. In the near future, however, the court will learn the truth about these institutions and find out that they are actually run for profit, and a decision will be rendered that will surprise some of them and throw down the bars for numerous damage suits. All of these questions are to be of vital importance to the X-ray operator, as it is through his art that many of these damage suits are started, and in each locality, some line of procedure must be worked out in order to determine his action in the numerous complicated cases that are presenting themselves.

Attitude to Institutions—It is clear that to the best of our ability we should try and protect the individual physician. This is well understood, but what attitude should we take regarding the numerous hotels that are masquerading under a charity hospital charter. We are compelled to meet them constantly in an unfair competition, and we must decide in the near future what attitude we shall assume toward cases of alleged malpractice happening in these places. They may delude the public for a while that they are free institutions, but the average physicians know that an institution which can sell beds, rooms, etc., for from $25.00 to $75.00 a week should be a money making institution, and has few claims for consideration at the hands of any professional man not connected with it. I do not believe a corporation should escape a legal liability that the individual has to meet, and it appears to me, after studying the matter carefully, that they should be treated like any other corporation, simply given a fair deal, and no special attempt made to shield their mistakes.

The constant growth of these institutions is a menace to the prosperity of the general physician. They have grown so insidiously and quietly during the last fifteen years that few physicians have stopped to consider the Frankinstein monster they have brought into being, a monstrosity that will absorb the entire profession, if the growth continues unchecked, and the average physician must become the hired man of some church institution within fifty years, if the same rate of progress continues —a very pleasing prospect surely, yet one that is likely to happen, as it seems no effective way has been found to control them.

I have decided the question in my own laboratory to my satisfaction. While I will not take a skiagraph of a case under the charge of a private physician without the written request, I will skiagraph any case that presents itself without question or comment that has been treated in a public institution. In this class of cases, the medical man is a mere incident, and if he is not competent, we may safely allow the superintendent to do the explaining.

There is no reason why we should protect them, at the expense of a poor patient who has gone to the place under the delusion that he could receive superior treatment. If they are burdened with malpractice suits, it is clear that many of the staffs will be much improved in the near future, and it is a duty we owe to our professional friends to see that the truth is made known regarding these places. While many of them are run on a very high plane, others leave much to be desired in their management, and publicity is the only cure for institutional evils.

I have been much criticized for this view of the matter by unthinking physicians, but if we stop to consider the matter why should we not treat them as they treat us? Have you ever been asked for your permission to allow one of your patients to enter the hospital? Has this institution ever asked you to allow them to pursue some

line of treatment or diagnosis with your patient? Surely you have always been consulted when they were about to perform an operation upon your patient. There is no reason why they should not be judged by their own standard of ethics.

FRACTURES—MEDICO LEGAL ASPECTS.

One of the greatest practical uses of the X-ray has been in the diagnosis of fractures. We are able for the first time in the history of medicine to clean up an obscure diagnosis, and ascertain why a simple sprain takes so long to get well, and why the serious fracture recovered so quickly and with such good results. We have all recognized the handicap in diagnosis under the old systems. Pain, effusion, hemorrhage, and personal idiosyncrasies of the patient always left us with the element in doubt.

It is with great reluctance I must carry my readers into the medico-legal phases of the subject; it is one not reflecting any credit upon either the medical or legal profession, and is gradually undermining the honesty of both professions when thrown in contact with it.

During the year 1907, I made skiagraphs of about 230 cases of alleged fractures that were pending in court as a "personal injury case" against corporations as cities, railways, and private enterprises. Of this number, I was enabled to verify the diagnosis in less than 25 cases. The rest showed unbroken texture of the bone, in perfect alignment, impossible in any broken bone.

This did not prevent the physicians from testifying to their alleged injuries, and taking their share of the "loot" from the corporate victim.

An abuse has grown up in this class of cases that has become a scandal to our profession. A certain type of physician joins a class of lawyers who have also been forced into dishonesty by the ethics of their profession, and by attaching to themselves a few people who are trying to live by their wits, and are not over particular

how they do it, we have a working combination that is a menace to anyone with property.

As a general proposition, the above start honestly enough, with a real injured person, but as soon as a few good verdicts have been obtained, and it is seen how easy the process works in practice, they are not any too scrupulous in taking advantage of anything that comes their way.

I know of one anatomical curiosity who has the ability of throwing out any joint of the body, who at the present time has over 40 suits pending against corporations in different parts of the country. He is a mainstay of the various medical-legal cliques in different cities. This individual, who has been an athlete, manages to get in the way of a street car suddenly, and allows it to bump him about twenty feet, when he is picked up, usually two or more joints have been dislocated. There are always plenty of witnesses present to see the accident, and he is hurried to a hospital, where his dislocations after being diagnosed and recorded, mysteriously slip back, convalescence is rather prolonged. The clique brings a suit in his name, and he may terminate his connection with the case there, after the railroad experts have seen him. He is personated in court by someone that belongs to the clique, and he takes in a cool $100.00 for his share in the plot. An individual whose business it is to travel on crutches, takes his place in several cities, as the plaintiff.

Many times some well meaning persons who receive a legitimate injury fall into their hands, and its gravity is magnified, and the mind played upon, until they are inoculated with the idea that they are a very much abused person, and a contract is obtained, giving the lawyer fifty percent of the verdict, while the witness fees, court costs and medical fees must be paid by the plaintiff. The story that has been suggested to him is taken down and signed before a notary public, and thereafter he plays a very subordinate part in the machine. All he is expected to do is to go on the stand and swear to the story he has

signed and sworn to, all the other details being managed by the clique. Occasionally, some sharp, shrewd party (either man or woman) who can stand the ordeal upon the witness stand well, is used to bring more cases against other corporations, or even against the same one, after changing their address, as the enormous volume of this business in a large corporation is so great that chances of detection are not great after a few months have passed.

When this combination is in action, one of the members locates a favorable place either to fall through a hole in the side-walk, or if a hole can't be found in the locality chosen, to see that one is made, and the city promptly given notice of the fact by the "disinterested party" route. Failure on the city's part to mend the walk in 24 hours according to the demand of the law, will cause the conspirators to assemble. The doctor, the witnesses, and the party who is to be injured are all cleverly arranged; ordinarily it is about 6 or 7 P. M., when it is getting rather dark. The poor victim walks along, falls into the hole, and screams lustily. The witnesses rush forward, lift him or her out of the hole, "the Doctor" makes a hasty examination, applies a temporary dressing, and a patrol wagon is called. The patient insists upon going home, and is accompanied by the "doctor", a "consultant" is called and the limb put in plaster of paris splints. The city's physicians are allowed to examine the case without removing the cast, and the deception is practised until convalescence is brought about, when the "victim" is ready for another injury in some other part of the town.

The railway companies are not quite as easy to swindle as other corporations, but the city—"It is like taking candy away from a child", as one eminent legal light remarked to me.

It is in a mess of this kind that the X-ray operator is introduced to our great and wonderful legal system, where they split hair very fine, and go away around Red Robinson's Barn in order not to find justice.

In this place you will swear to tell the "truth, the whole truth, and nothing but the truth" and will find yourself lucky if you get a chance to tell more than your name and give your college appointments. It is not necessary to put in much study on the case, but it is very important to know just what time you were convicted of some crime, and what prison you received your primary education at, and if you have never had this honor, why did you miss it? The defendant is never on trial—or at least it seems so, but the witnesses and jury are constantly under suspicion.

A trial in court has degenerated into a baseball match, where they take sides, and hit the other player with a bat when the umpire is not looking, and any self-respecting physician owes it to himself and his profession not to testify as an expert, except at the request of the judge.

It does not make the slightest difference what evidence is given on one side of a case at present; plenty of experts, equally as good, will appear to testify that black is white. This has gone on for so many years that the mention of a medical expert excites a smile in legal circles.

The young skiagrapher must watch out, or before he realizes it, he will be a part of the machine, as the above is so subtle, and far-reaching and involves so many that apparently stand high in the professions, that the novice will find himself bound with chains before he suspects that anything is wrong.

The part he is expected to play is an important one. It is the part of wisdom to settle all of these cases that can be setttled out of court, and, if a fracture is claimed, it is up to the skiagrapher to show this fracture as described by the surgeons, and a very little practice soon gives him the knowledge to do this work with impunity.

As a general rule, the easiest way is to exhibit a plate taken from some other case; but if one showing the particular fracture is not in stock, he soon learns to supply the deficiency by making a skiagraph of the part, working in the proper fracture with a pencil, making a positive

and another negative in order to remove traces of the work, and he is equipped with the proper plate to back up the surgeon's description, and many settlements are made on the basis of this "evidence". Occasionally the plans go wrong, and as a reference case the patient is referred to some other skiagrapher for a plate, and it is of great importance that he be deceived. This has been done successfully numerous times by carrying a needle syringe down to the bone, and a trail of iodoform and glycerine left across the bone in the line of the supposed fracture. This, of course, is always in a line where the average operator would be apt to place his plate and tube.

I accidentally found out the swindle, and since this time I always make a plate at right angles, and it is very instructive to see the supposed fracture lifted off of, and clear of the bone.

I successfully demonstrated the fraud in court at one time. Everybody had a good laugh, while the case was withdrawn. It seemed very humorous to all concerned, —even the judge had a hearty laugh, and makes one wonder where the dignity of the courts will be if a bald faced swindle is so highly amusing to the court.

I have called attention to the above, not because I am expecting to bring about any reform. It is impossible to do so at this late day. It is so thoroughly grounded among the "grafters" in both the medical and legal profession that no relief will come until the people rise in their might and do away with the present rotten legal procedure. It has got to the point where the people no longer respect the courts. A majority **fear** them, and will submit to almost any wrong rather than appeal to them for protection.

It is into a condition of affairs as outlined above that the young skiagrapher will soon find himself entangled, and in these days of **Frenzied Finance,** he will have to be very suspicious of all legal work that comes to him, as a young friend of mine got caught in the net and finds out that he is absolutely in their power, as they have the

documentary evidence to send him to the penitentiary if he fails to come up to expectations, and he has no relief in sight, except to play the "baby act" and turn state's evidence. Don't get into the power of this **Ring** or you will never get out, and will be practically compelled to do as they wish.

It is conceivable that a fracture might occur that would not show several years afterwards, providing it was not complete at the time, and no displacement had occurred, but this condition must be a rare one, and could happen in only a very small number of cases. At least, the plates should be taken of all suspected fractures and preferably at right angles, and if no line of fracture is seen, it is good, positive evidence that no injury of bone tissue has been received.

To be on the safe side at the present stage of development of the X-ray, all fractures should be skiagraphed both before and after the permanent dressings have been applied, and any physician or surgeon who does not take this precaution will soon be held liable by the courts for negligence. The trend of some decisions in recent years goes toward supporting this view.

The skiagrapher is frequently placed in a painful position by the attitude that is taken by many members of the profession. A case in point might be quoted: A fracture of the forearm was received, which was examined and replaced by a prominent surgeon. The arm was found useless after four months, and it fell into another physician's hands, who sent it to me for a skiagraph. This plate showed an extremely bad result, and was shown to the attending physician for his guidance, and when the facts were learned, he was advised to allow me to break the plate, as soon as it had served him as a guide to attend the arm. It seems, however, that the patient was not looking for anyone to fix his arm, but was on a still hunt for evidence so he could bring a damage suit against his medical attendant. We found out his intentions in time to destroy the plates, before they were impounded

by the courts, and no damage was done, except to our feelings from the abuse of his first medical attendant.

The American Medical Association should make a rule to cover cases of this kind. The possibilities of abuse of the X-ray in unscrupulous hands are enormous, and the use of this agent for both radiographic and skiagraphic purposes should be kept well into the hands of the profession, who naturally have the interest of their conferers at heart.

One view of a fracture may give a distortion of extreme importance, while another might show a simple fracture with very little displacement, so that where the long bones are involved in a fracture, two views should always be taken in order to see if the bones are in alignment. It is possible by this means not only to determine the fact of a transverse oblique, or multiple fracture, but to account for every fragment of the bone. Many times a fracture proved to be a painful one for no apparent reason, and surgeons have talked glibly of the nerve having pinched in the provisional callus.

Many cases of painful fracture skiagraphed in the last five years, have shown a splinter of bone, driven into the soft tissues as the cause of the pain, and its removal has been followed by perfect relief. Many times the cause of fracture can be ascertained and found to be due to disease of the bones.

One important case of this character where I was able to render the surgeon a signal service was where he had failed to get a union, and trouble had been threatened. He persuaded the patient to have a skiagraph made, and I found that the bone for four inches, both sides of the fracture, was sarcomatous. Moreover, we found that the opposite femur had several focii of sarcoma; further search revealed a forming sarcoma of the heart, that had not been suspected. The X-ray can furnish information about a fracture that cannot be obtained in any other manner.

METHODS OF EXAMINATION BY X-RAY.

Fluorescent Screen—Under suitable conditions, a good examination by the screen may be made. If the room is perfectly dark, the vacuum of the tube just right, and the screen new, much information may be gained that is valuable, but a thorough knowledge of the appearance of the normal fluorescent image should first be ascertained, as it is possible for serious mistakes to occur. A number of instances have been brought to my attention where a fracture has been overlooked, owing to the fact that no displacement had occurred, and the fracture following an oblique line.

If a fracture is seen with the screen, a study of its relations can be made with the limb in different positions, until a position is found where all the muscles are relaxed, and the bone falls in normal position, and the dressing may be applied while in this position, with the best reason to expect perfect results. If considerable of this work is done, the operator should not forget that he may absorb more X-ray than is good for him, and a bad dermatitis or alopecia may be produced. Prolonged seances with the fluoroscopes are dangerous to both operator and patient.

Examination with Skiagraph—This gives the surgeon a positive working knowledge of the injury, and enables him to treat each case from a standpoint of its own special features. No mistake can be made if good skiagraphs are taken at right angles to each other before treatment, and two more after the permanent dressing has been applied. A case presented itself in my laboratory of a girl of eight years, who was suffering of a fracture of the humerus above the lower condyles. A note from the attending surgeon accompanied the child, stating that the arm was set all right, and that he desired a skiagraph to protect his interest in case of a bad result. This was made and it was found that a displacement forward of the upper fragment had occurred, amounting to one inch, the upper fragment

resting upon the head of the radius and ulna. It can be readily seen what a deplorable result would have occurred, as the arm was put into plaster and would not have been changed for six weeks. It is needless to say that the trouble was immediately corrected, and another skiagraph confirmed the position, much to the surgeon's relief.

It is of interest in passing to say that the fluoroscope was used by the surgeon to confirm the position after the plaster dressing was applied, and he must have received a very unsatisfactory view, and failed to detect the displacement.

Many errors have occurred in fluoroscopic examination, where the epiphyseal line is still present, and it is interpreted as a fracture. The same mistake has been made by new operators with the X-ray, and I have met several such pictures in court, called fractures. This could only occur where the operator is not familiar with the skiagraphic anatomy, as it presents its peculiarities at different ages. Errors may be avoided many times by making a skiagraph of the normal limb in order to compare it with the one under suspicion. Where possible, surgeons should use permeable splints and dressing in order to allow the skiagraphers to get clear plates of the injury after the permanent dressings have been applied, while a skiagraph can be made through metal splints by regulating both the vacuum and exposure. The chances of failure are very much increased, and are never as successful as we could wish.

Stereoscopic Examination—This beautiful process, so familiar to all of us many years ago, has been adapted to skiagraphy. It requires an elaborate paraphernalia in order to produce a satisfactory image. There are many ways that the process can be worked, but the simplest method is by having a suitable table containing a plate holder, so that it is possible to change plates without disturbing the patient. Two exposures are made with the plate and patient in the same position, the tube being moved one and one-half inches each side of the center

line during each exposure, or both exposures made with the target of the tube three inches apart, the tube being moved from right to left between the exposures, and while the plate is being changed. By this means, we obtain exactly the same view as we would if we could look through

A BONY ANCHYLOSIS OF OLECRANON PROCESS

SAME CASE, DIFFERENT VIEW

the part with our eyes. After the plates are developed, they are placed in a suitable frame, with a light behind the negative, and are focused so as to throw their image on an acute angle mirror. It is necessary to transpose the plates on putting them into the frame, and both plates must be focused so that their images are synchronized on viewing the double image by a common stereoscope. By this means we obtain a relief of the view, and the bones stand out from the field, and it can be ascertained if a foreign body is in front or behind a bone, and its depth calculated.

A beauty is seen in these skiagraphs not dreamed of by other operators, and their value is enormous from a diagnostic standpoint. Unfortunately, surgeons will not authorize their patients to pay for the extra trouble necessary to produce fine work. There are great possibilities

of improving this process and simplifying it in such a manner that our cumbersome apparatus may be more readily adapted to the process.

SKIAGRAM IN WHICH THE CONVOLUTIONS OF THE BRAIN WERE SHOWN

Skull—In examining the cranium for fracture, the fluoroscope should always be used, as the most favorable position may be found to make the plate, but many times the fluoroscope will give us no information, and then we must make at least two plates at right angles to each other, and usually we can get all the information we desire. At present we are not able to demonstrate a fracture at the base of the skull with any degree of satisfaction but by making several exposures from different angles, with the plate as close to the base as possible, we can frequently demonstrate a fracture, but at present the method is not reliable.

Vertebra—This part of the body offers many difficulties in the Dorsal region, owing to the necessity of passing the ray through the manubrum and sternum, and thereby clouding the shadow thrown upon the plate by the vertebrae. The best position for the plate is under the back, and a ray used that makes the manubrum and ribs practically invisible, and better results are obtained by backing the plate with a lead plate at least half an inch thick. In many cases, they can be brought out as clear as the Lumbar vertebrae. It is better to make three plates —one for the cervical, dorsal and lumbar region, as the exposure is different for each part of the body, and it would be impossible to get a good view of all three parts of the vertebrae on the same plate. We can use an in-

tensifying screen of Tungstate of calcium when we attempt to skiagraph the dorsal vertebrae, and will get only the outline of the vertebrae and its rib connections.

Shoulder—A skiagraph is frequently our only means of clearing up a diagnosis of a fracture or dislocation of the shoulder joint. The severe pain manifested by some patients after slight injuries, makes manipulation of the arms out of the question, and many "so called" cases of ascending or surgical neuritis have been found due to disease of the head of the bone or a dislocation. A very fleshy or strongly muscled patient may present a perfectly normal appearance to an ordinary examination, but presents few difficulties to the X-ray.

FOUR MONTHS AFTER, IT HAPPENED AT A LARGE HOSPITAL. DUE TO A PLASTER OF PARIS DRESSING

Several cases have presented themselves in the last few years, with the disability of the shoulder, and I have found and reduced an old dislocation. Two plates should be made with the arm close to the body and the other with the hand on the back of the head. In this way, we get a good study of the interior of the joint from its best point of view.

EPIPHYSEAL DEVELOPMENT.

Much of our knowledge of epiphyseal development has been found inaccurate. The X-ray has been able to show us that many joints are slow about depositing lime salts, and the X-ray has shown that many physicians have forgotten the usual history these cases pursue.

I have been called in court many times in the last ten years to testify that the alleged fracture shown by the negative was an epiphyseal union, with no fracture present.

Some young man who has time, equipment and material, can gain fame, and do the profession a good turn, by a succession of exposures of some particular joint, at different ages. These should be put in book form as a guide to follow in medico-legal work.

Dr. Hickey of Detroit, has made a good beginning with the elbow joint and others should take up other joints in succession, until the long bones are covered.

DENTAL SKIAGRAPHY.

Dr. Price has given us a very satisfactory technique. He uses a triple coated film of celluloid, rather flexible, and places the film face to face with Bromide paper and covers a 4 x 5 film and paper with unvulcanized black dental rubber—a very thin covering called Dougherty's. This adheres to the paper and film, and he then cuts them up into nine squares, and after trimming off the corners, folds the rubber over the edges.

He fixes the head firmly in a dental chair, and after introducing the plate, makes a quick exposure with a hard tube. He advocates the use of a contrasty developer, diluted, in such a way as not to cause a fog, while it is penetrating the great thickness of films.

Dr. Lester Custer uses a film cut and placed face to face and covers it over with two layers of parafined black needle paper. He claims that this is all the protection required. Upon development, we get two views, which shows two densities, and is of great value at times.

PYORHOEA ALVEOLARIS.

Dr. Weston A. Price reports several cases treated with the X-ray, and with a very satisfactory result. He says every case treated this way showed marked improvement.

He claims to have treated several very bad cases with the teeth loosened and bathed in pus. After a short time, the pus dried up, and the teeth became firmly seated, and the patients more comfortable.

This, he claims, is more than can be done by any other method, and while not universally successful, he is satisfied with the majority of cases treated.

In this, Dr. Price is wrong, as I have had the pleasure of watching Dr. J. F. Kelly of Chicago demonstrate his own method, and he has made it clear that this disease is one of the simplest things to cure if it is properly handled, and that no case is helpless. He maintains that this disease is not a constitutional disease, but is local.

FOREIGN BODIES.

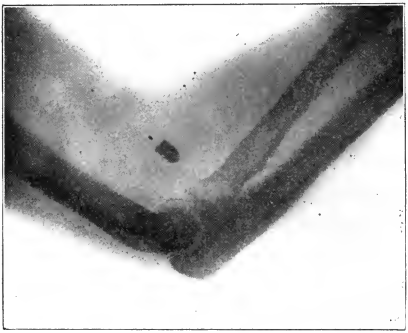
The Radiographer is frequently called upon to locate foreign bodies as needles, bullets, buttons, safety-pins, etc., in fact, nearly every conceivable article small enough to be swallowed. I have found so many articles of junk in the human body in the last few years, that I have seriously questioned if some members of the human family haven't descended from the Ostrich.

I have often wondered how a man could live with so much indigestible material in his intestines and stomach. One Freak in one of the local museums showed over 200 pieces of glass, nails, screws, etc., within his abdominal cavity. Another extremely interesting case presented itself with a diagnosis of consumption, and had the physical signs of tuberculosis. One lung consolidated with hitching rals in the other, and a skiagraph was made in order to see how much lung tissue she had left, when much to the surprise of every one concerned, a shoe button was located in the right bronchus. She was only eight years old at the time and had no recollection of when the accident happened. She was put to sleep and an attempt made to remove it, but owing to the way she was taking the anesthetic, it was considered wise to desist until such a time as she could be gotten in better health. One year

was spent in preparation and at last Dr. Howard Chislett removed the button through the back, after I had carefully relocated it by means of the X-ray. No special difficulty was experienced in finding it through a small incision. She made a wonderful recovery, although the right lung has never developed, remaining in a shrunken condition, while the left has expanded until it occupies with the heart, both sides of the chest. One curious fact has been noticed in this case, namely, that while the girl has improved in health, her growth has apparently been stunted.

A common class of foreign bodies usually are found in very small children who swallow either an open safety pin or a penny, generally both of these articles lodge behind the manubrium and may frequently be removed by means of the throat forceps. Many errors have been made by using the fluoroscope for this work, especially where false teeth were lost. It is probably not new to many to call attention to the distressing accident that occurred in this country, where a man missed his teeth one morning on arising, and as his throat was sore he jumped to the conclusion that he had swallowed his teeth. They were promptly located by the fluoroscope in the upper part of the oesophagus and he was removed to the hospital for an operation. The forceps failed to locate them where the image was seen and as a bougie was passed without difficulty the patient was anesthetized and his stomach was opened in the belief that they had passed downward during the journey to the hospital. About this time a messenger arrived and ran into the operating room with the missing teeth, which had been found in the bed. The unfortunate result in this case was the death of the patient from the anesthetic. It should not be necessary to say that the image seen in the fluoroscope was the shadow of the hyoid bone, a mistake that could not readily happen with a skiagraph. An operator should never depend upon the fluoroscope for a diagnosis of foreign bodies. This was emphasized in another case referred to me for diag-

nosis. A lover's quarrel resulted in the attempt on the youth's part to commit suicide in a spectacular manner in her presence. She seized the weapon and in the struggle it went off. She had a stinging pain under the right breast and immediately lost the use of the left arm. The young man on being arrested made the claim that the revolver contained only blank cartridges and consequently no injury could have been inflicted, that the obvious re-



BULLET ENTERED RIGHT BREAST, DEFLECTED FROM ACROMION PROCESS TO ELBOW

sult must be due to shock. She was examined by a number of physicians who owned X-ray machines and they testified after the most careful fluoroscopic examination that it failed to show any bullet and if a bullet was present it would show. Surgeons on the contrary claimed that a large nerve trunk had been severed, and she was referred to me by the judge, both sides agreeing to abide by my decision.

I made a number of skiagraphs and found a bullet lodged in the head of the coracoid process of Scapula. The bullet showed plainly in the skiagraphs and was subsequently removed by the surgeons. The cases cited are only a few of hundreds that have occurred in my practice.

where the X-ray has supplied the missing link in the chain of evidence.

A notable case occurred in a woman 32 years old who had a running sore upon her hand. It had been present six years and had been pronounced tubercular, causing her considerable pain and distress. It was referred to me by her physician for Radio-Therapeutic treatment. I preceded the treatment however, by making a skiagraph in order to ascertain the condition of the bone, when to the surprise of every one concerned, a needle was found in the palm of the hand, one and one-half inches long, whose presence was not suspected and could not be accounted for by the patient. Her hand had been examined by the fluoroscope and she had been treated by the X-ray for tuberculosis of the hand, but the result not being all that the practitioner desired, she was referred to me for treatment. The removal of the needle was followed by cicatrization and relief of pain. These cases are quoted to make the operator more careful and not to take things for granted, because it should be thoroughly understood that the X-ray don't make mistakes; these are made only by the operator, either in technic or interpretation. There are many principles used in accurately locating foreign bodies, especially bullets and pieces of steel in the eye that we must be familiar with, if we are to be of real help to the patient, and it is a misfortune that surgeons are so reluctant to avail themselves of the wonderful help that can be given them by this agent, so that enough work could be done by one operator to pay him to develop his technic to a fine art. But unfortunately, surgeons prefer to spend hours looking for these things rather than the minutes that would be necessary to properly locate them by a few skiagraphs. The location of foreign bodies in the eye is a rather delicate task, requiring a good eye, good judgment of angles and a perfect technic to give a plate, so that the oculist can assure his patient and determine the terrible question of saving or removing the eye to avoid sympathetic ophthalmitis. If a foreign body passes

entirely through the eye it is rarely necessary to remove it, while if it remains in the eye destruction is very sure to take place in both eyes if the injured one is not removed promptly, so that the responsibility of the X-ray operator may be appreciated when it is his duty to settle this question, and it is to their credit that it is generally correct. I made a mistake by a narrow margin in one case, the shadow on one plate showing the foreign body just behind the eyeball apparently in contact with it, but as the eye gave so much trouble, it was removed and a particle of steel was shown projecting through the posterior wall of the eye, teaching us to allow one-sixteenth of an inch for the displacement of a pencil of light striking the plate at an angle.

Bullet in the Limbs—Bullets in the limbs can usually be located without any elaborate paraphernalia. The limb is placed in a natural position upon a plate and a cross of fine copper wire, inked with pyoctanin solution put upon the center of the plate, marking its position upon the limb, and after the exposure upon the plate. This gives us a landmark so that we can place the plate in contact with the limb, matching the wire marks of the plate with those of the limb, the position of the bullet is indicated by a mark, the process is repeated at right angles, another plate being necessary, and by that means we have two marks upon the limb, locating the foreign body at the apex of the triangle. The incision should be made in the shallower plane in order to prevent too much mutilation of the tissue. Frequently the skiagrapher will do his work well and the surgeon will insist upon knowing all about the case, refusing any suggestions, with the result that he spends several hours hunting for the bullet and finds fault with the X-ray.

I had one case that illustrated the trouble well. A boy was shot in the leg and the bullet was located in the quadreseps muscle. It was carefully located and found only two inches deep. Both angles were shown on the skin, and a line of incision drawn and the posi-

tion of the limb indicated where the plate was taken. He started the ball rolling by contemptuously remarking that these X-ray men exaggerated the importance of their work and seemed to assume that surgeons could not interpret the skiagraph as well as they could. He was very confident for one hour and talked of the fallacies of the X-ray; what an unreliable agent it was and sent out for me in order to "rub it in" before the class. I found him operating with the knee joint at an acute angle while the plate had been taken with the joint straight. I took the patient by the heel, and straightened out the limb, when to the astonishment of the class the bullet appeared in the wound. The position of the limb had moved the foreign body four inches from the skin incision. There are many side lights in the use of the X-ray that don't allow any individual to pose as an all-round expert without running the risk of public humiliation.

If the bullet has lodged in the trunk or the cranium, we find that we must use a geometrical process to locate the depth. This has been worked out by McKenzie Davidson and an apparatus devised for its interpretation without the use of mathematics. This consists of a table with cross rulings corresponding with the lines of the screen; the latter is placed over the plate, the body is indelibly stamped with a cross section of the screen and is impressed upon the plate by the ray, keeping it in close contact with the latter as possible. A tube is placed 20 inches above the plate and one and a half inches to the right of the suspected position of the body and enough exposure given to impress the image of the body upon the plate. We then move the target of the tube to the left just three inches and make another exposure on the same plate of sufficient length to impress the image of the body in another place. On development we will get two images of the foreign body and having the known distance between the shadows on the plate and the distance of the target of the tube, as well as the base of the upper and lower triangle, and it readily will appear that all these

factors being present, it is a simple matter to calculate the apex of the lower triangle, which will give us the exact depth of the bullet, or we may use a sheet of paper and make a rough draft of the arrangement and by watching where the lines cross, we can take a rule and measure the distance. The Davidson apparatus simply consists of an upright to represent the two supports with two cords three inches apart and weights at the other end in order that they may be moved to the shadows on the negative, so that the apex of the triangle could be measured. By using this method we do away with the necessity of calculating the apex of the angle and accomplish the same object.

Harrison in the British Medical Journal Jan. 1st 1898, devised a localizer based upon the Davidson method which he considers more simple. In April, 1898, he modified this method so that the whole object, or as many angles as necessary might be found, but is of doubtful utility, as the main object in all localizers is the approximate location of a foreign-body, as surgeons can explore almost any part of the body with perfect safety. He says:

"The stand of my focus tube is seven inches wide, and about 18 inches long, and I fix the tube so it is about 7 inches above the board. The tube can be moved to either side, and a point is marked on the extreme edge of the board on each side directly under its center, these points are joined by a straight line, and a line is drawn at right angles through the center of the first line. The plate should be so placed that its center coincides with this point when an exposure is made with the tube over each lateral point upon the same plate, and upon development the distance of the image from the side of the board carefully measured. I now draw on a board a square of seven inches and divide one-half in a scale, on this scale I mark the distance of the object from the side of the board with two pins, two threads are now fastened at opposite corners of the board to these pins on the scale. Their points of intersection will show the position of the object."

JOINT DISEASE.

The diagnostic features of the ray in this class of troubles is invaluable, and it has been demonstrated time and again that other methods of diagnosis are erroneous. This might be illustrated by a young lady I have known many years, she had gone lame and gradually grew worse until it became necessary to seek medical help. She was referred to one of our best surgeons and he made a diagnosis of tuberculosis of the hip joint, which he injected several times with iodoform and glycerine without improvement, then he recommended rest. She gradually grew worse until she consulted an osteopath. This gentleman recognized the difficulty as a "dislocation" and gave her assurance of immediate recovery. He grasped the ankle and knee quickly and forcibly bent the femur over, causing extreme pain. Investigation afterwards disclosed the fact that the leg had been shortened by the procedure from three-fourths of an inch to three inches, and that she could not use it, now she had a dislocation sure enough, and any medical man was fearful of trying to reduce it, owing to the diagnosis of tuberculosis, so she had to get along the best she could for several years, until eventually she fell into the hands of an X-ray operator, who out of curiosity made several skiagraphs of her hip, and after careful study came to the conclusion that the girl was suffering from Coxa-Vera; she was put on Phosphorus and the joint opened. It was found free from tuberculosis, the dislocation was reduced and proper splints applied. The wound healed promptly and in ten weeks she was walking with a cane, and in fourteen weeks with scarcely a perceptible limp. She is well now and owes her salvation to the curiosity of an X-ray operator who was looking for information regarding tubercular joints and spending his time and money trying to get it.

This case is only one of many illustrating the danger any patient runs who has some obscure trouble and a diagnosis from some prominent man of tubercular infection.

This diagnosis seems like a gold piece, it is "Legal Tender" anywhere in the world. No one seems to think for a minute of the difficulties of making a diagnosis that were almost insurmountable, and that it was made by a very busy and tired man, "many times without a fee," and based more upon subjective symptoms than any thing he was able to find; but his examination is like the stamp of the mint in medical circles, no one questions its value. Moreover some of you may have noticed that there are "fads" in diagnosis, especially in obscure diseases which change periodically with the trend of medical thought as seen in

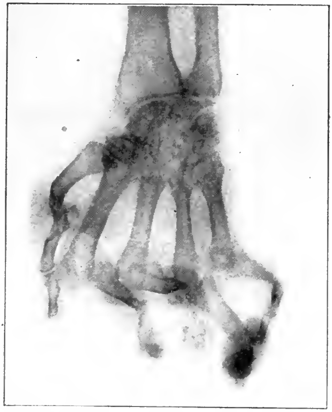
CONGENITAL DISLOCATION OF HIP-JOINT

SAME CASE AFTER BEING REDUCED BY DR. FREDERICK MUHLER'S BLOODLESS OPERATION. (SIDE OF PLATE REVERSED IN MAKING ENGRAVING

the journals. The psychological fact remains that many minds are influenced by these so-called " medical symposiums" that take place from time to time in both the medical societies and certain journals. The only brand needed to make them all take the bait is plenty of "conservatism."

The fact remains that diagnosis of joint diseases has been in a chaotic state for many years, and it is owing to the introduction of the X-ray that order is beginning to assert itself. We find many joints that have been pro-

nounced tubercular, are due solely to gonococcal infection, explaining why so many tubercular joints recovered following an injection into the joint, and why so many did not improve after the procedure. Usually, if a tubercular infection has existed for a number of months, the texture of the bone is destroyed, and irregular lines of infiltration are found radiating away from the joint. This view is never seen with infection from the gonococci.



ARTHRITIS DEFORMANS. THE PROCESS WAS APPARENTLY STOPPED BY THE X-RAY

Arthritis Deformans—Deposits in the joints from Arthritis Deformans can be shown well with the X-ray and help to clear up the diagnosis of Chronic Rheumatism; with the latter, we will find a decided increase in the thickness of the cartilage that covers the ends of large bones.

If we wish to examine the texture of the bones, a tube with a parallel resistance of five inches brings it out to better advantage, while if we wish to examine the soft structure, a tube giving a parallel resistance of one inch will show them plainly.

For the latter plate, the developer should be diluted at least one-half in order to bring out all the fine detail, and not cloud the fine half-tones. It will pay any operator to make a series of skiagraphs of the same joint, using different tubes, with increasing resistance, and gradually increasing the strength of the developer in order to study the wonderful possibilities that there are in X-ray diagnosis.

He will find that he will get a plate showing some of the soft tissues, and a plain shadow of the bone, and as he gradually increases the resistance, tissue after tissue appears and disappears, until nearly every structure appears upon some of the plates. It is impossible to get all of the tones that we expect upon one plate, owing to the slight difference in the atomic weights between the different structures.

When there is great swelling about the joints or effusion within them, it is frequently difficult to get sharp and clear skiagraphs. This is owing to the increased distance of the plate and the relative amount of ray that is absorbed by each structure traversed. As a rule, the lower the tube, the greater the contrast we will have in the plate, and the greater range in tones.

Sinus—Many times we are in doubt how extensive a sinus may be, and the direction it takes. By injecting into it an emulsion of Bismuth Subnitrate, we can make a skiagraph that will furnish the information in a beautiful way. The skiagraph shows every little fine ramification standing out with distinctness, and giving the surgeon a comprehensive view of the work before him.

The method has been used in Tubercular abscesses of the fascia planes of the back. The emulsion has been injected under considerable pressure, and in 24 hours, a skiagraph will show the extent of the infection, and frequently point to the real foci, where it has not been suspected.

CEREBRAL SKIAGRAPHY.

Few phyisicans are aware of the great value of the X-ray in diagnosis of conditions within the skull, and for this reason, this part of the art is neglected. The value of the process is modified considerably by the make-up of the individual. As a general rule, remarkable detail may be obtained in a cultured and brainy individual, owing to the thinness of the walls of the cranium, and we gradually lose in detail as the skull increases in thickness.

In several instances, I have been able to outline the convolutions of the brain, but this can be done only in a few instances. Collections of pus, tumor growths, when of a different density from the surrounding tissues, collections of fluid in the ventricles, bullets, or foreign bodies are easily shown.

The technique varies with different operators. I prefer to use two films, to sort out rays of different length or degree of hardness, and leave only the hard rays for the glass plate. This gives us three plates, each showing a selective absorption of a different wave length, and by registering either the two or three films to the plate in a viewing stand, a wonderful wealth of detail appears. This can be printed upon the ordinary printing out paper. if desired.

It has occasionally happened that a tumor has appeared by this method, which could not be seen in any of the plates when viewed separately. This is accounted for by the slight difference in density of the tumor failing to absorb enough to render its presence visible, unless each plate shows a very slight diffusion so that when superimposed, the image stands out with startling clearness. A hard tube that has had considerable use, has given the best results in my hands—one that backs up 3 to 4½ inches parallel resistance, depending upon the thickness of the skull.

I have succeeded a number of times in locating a suspected tumor by this method, and have the satisfaction of two of them being removed successfully. It should not be forgotten that several cases of severe disturbance of cerebration has followed exposures to the head.

Effect of Ray on Brain—Dr. Emil Grubbe has reported one case with wild delirium, with hallucinations, that lasted for several weeks, and another that had the symptoms of dementia develop shortly after the exposure. This I have observed three times during my earlier work. and it is well to bear it in mind.

It would not be safe to assume that these effects are due to the ray. It may have been a mere coincident. Yet, when we consider the profound effect of the ray upon highly complex tissue, it is more than probable that it is capable of great harm, and should be used with the greatest caution.

DENTAL SKIAGRAPHY.

The use of the X-ray has become almost indispensable to Dentists. By this process we can turn a shrewd guess into a naked certainty and allow the operator to adopt the proper procedure in a given case.

All Dentists have cases present themselves with an ill defined ache in either the upper or lower jaw, which the most careful examination fails to reveal the cause. The question of an abscess, unerupted teeth or caries of the bone, many times it was months before the diagnosis was cleared up, under the old method. It is now the skiagrapher's duty to find the cause of this trouble, and it is seldom that he fails in so doing.

Value of Process—This branch of the art is upon a very satisfactory basis. The work can be done with precision, and almost invariably a good plate can be made of the tooth under suspicion. By this process, we can detect any change in the structure of the bones, loss of detail, the germs of unerupted teeth, the accumulation of gas or pus around the root of a tooth, exclude antrum disease, ascertain the correctness of an operator's work, whether he has filled a tooth canal to the tip of the root, and if he has filled all of the roots the same way, disease of the peridental membrane, and occasionally some gas under the filling of a tooth. The detection of broken instruments, that some careless operators have left in a tooth, because of the difficulty in removing them, are all laid bare by this beautiful process.

The technique is quite simple, but difficult to describe so as to convey to the beginners a fair idea of its working form. The different configurations of the roof of the

mouth vary within wide limits, and a certain amount of adaptation is necessary for each case. As far as may be practical, an effort should be made to place the tube at right angles to the sensitive film; this offers no difficulty in a mouth with a high arch, but as this structure flattens out, we must increase our angle from 90° to 145° in certain cases. Little distortion ensues at 90°, but we have a foreshortening that grows greater the closer we approach 145°, until the shadow of a normal tooth may reach one inch at the former angle, we find it may not be more than 3/8 of an inch at the latter. It has been my experience that the average negative can be taken at an angle of from 110 to 130 degress, and generally the dentist is quite satisfied with the view obtained.

Technique—Some flexible photographic film must be used. This is to be enclosed in black paper, and with a covering of gutta percha tissue. This is introduced within the mouth, and held by the finger or some mechanical device, so as to approximate the film to the proper locality.

A hard tube with about 3½ inches resistance gives the best results. As a rule, a liberal exposure, with a dilute developer or an old one that has been used upon other plates, gives the best results. The process must be carried farther than other skiagraphic work, in order to bring out the detail in the shadows. Great care must be used to protect the film from the darkroom light, as a very slight fog in the shadows will spoil the fine, beautiful details in the bony structure so necessary to success.

If possible, the head must be fixed in order to prevent the slightest motion during exposure, or our plate will fall far short of what the dentist expects.

Dr. Price, of Cleveland, has probably done more of this work than any other man, and has devised many ingenious mechanical appliances to overcome the technical difficulties of the process.

I believe the best results are obtained with a tube shield in place, allowing only a small pencil of rays to pass through the structure we are skiagraphing. This avoids

the possibility of secondary rays, and gives sharp, clear negatives.

The films, after exposure, are developed in the ordinary way, and with the solution prepared for other plates. The only exception is the necessity of giving them a bath in a ten per cent glycerine solution, after they are fixed and washed. This prevents the curling of the film, and makes them easier to print.

We can make a photograph of our negative by using some of the glossy developing paper, developed with the standard formula sent out by the makers.

THE X-RAY IN THE INDUSTRIAL WORLD.

The X-ray has found its way slowly in the diagnosis of accidents of our modern industrialism. The "penny wise and pound foolish" policy of the men having this department in charge, has been the apparent reason, and it has begun to impress it's value upon them only during the last two years. They have had the value of the process forced upon them at the business end of a large verdict; they have had to pay where a skiagraph was the most convincing evidence.

Nearly all of our Industrial Corporations have "Farmed" out their accident cases to some Insurance Company, and this has been the main reason why conditions have remained in such an unsatisfactory state. These companies have depended upon perjury, delay, and brow-beating tactics to settle cases of personal injury. This has been a satisfactory way in the past, owing to the procedure and delays of our courts, where it was impossible to bring a case to a hearing inside of four years.

The establishment of our Municipal Courts, however, with their common sense procedure, has made it possible to register a verdict under $1,000.00 within ten days. This has been taken advantage of so freely by litigants of this variety, that many of the large corporations have withdrawn their work from the Insurance companies, and have their own department. They have placed in charge

of this work, a broad-minded man, who is loyally supported by a good corps of physicians on a salary basis. The poor devil who is injured is no longer looked upon as an enemy to be fought by all means fair or foul, but as an unfortunate human being, who is their guest, and charge for the time being. This has brought out a better spirit in both patient and doctor, and as the latter is under salary, he does not care how much he is bothered by the patient calling to see him.

A much better class of medical men are being retained, and the Department cheerfully audits bills for outside talent where it is thought necessary to call them in.

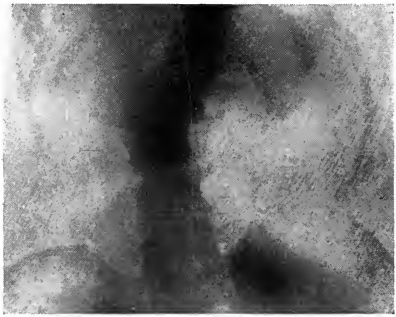
The Expense of the Department—The expense of inaugurating these Departments has been great, yet the Corporation is saving money and making friends; they are giving a square deal, and demand one, and from the immense saving in the Department so far they are getting it.

The advantage of having trained help at hand, and a proper institution to send a patient, with no delay, all contribute to their success. The human sympathy, and optimistic spirit, keeps the patient encouraged and gains his confidence. They are now keeping the patient under their charge until he is able to earn his livelihood again, when a fair settlement is made with him for the time he has lost and such inconvenience as he has suffered, and both parties are satisfied. The thought held before them is this: "Accidents are not avoidable under our present system, owing to the carelessness of our employees and the public, so that we are willing and expect to pay for injuries received, until our system is so perfected as to do away with them".

The frankness of the Company stimulates a certain amount of confidence in the injured party, and he will freely admit his own carelessness in the matter, and I have known them to refuse a settlement on the ground that they alone were to blame, and the Company had done all that could reasonably be expected of them.

Where a party will not listen to reason, or has an exaggerated idea of the amount of damages or the sum of money they are entitled to have, a determined legal fight is made on the merits of the case and the Company generally wins.

Very few of our Industrial Corporations have learned the value of the X-ray. Physicians who are in charge of this Department have not adjusted themselves to their place in the proper way. They are so anxious to make a good showing by cutting down expenses, that many times they are content to allow a "guess" to pass for a certainty. In my own laboratory during the last year it has cost the Industrial Corporations over $10,000.00 in verdicts that might have been avoided. Over 300 cases were skiagraphed. Of Industrial injuries at least 80% showed no injury of the bony structure, where fractures were claimed; 10% showed an error of diagnosis, 6% correct diagnosis, but poor apposition of fractures, 4% showed either former trouble, as malignant disease, or some anomaly of the part.



LUMBAR VERTEBRA, BROKEN BY A CAPSTAN ON SHIPBOARD

At least 60% of the cases would have been dropped if the Company knew the facts, they would not dare push the case in Court, and yet these facts, that are well known to all Railway Surgeons have not influenced the Com-

panies sufficiently to make special provision for the X-ray diagnosis of this class of cases, and it is probable that many years will elapse before it is generally used.

From the many years of experience I have had with cases of this character, I am inclined to believe that an X-ray diagnosis should be made in at least 75% of these accidents. It assures the patient that the physicians are competent. It can be shown to the patient, its special features pointed out and a good working idea given the patient as to what is expected of him, and why. You may tell the average man that his leg is broken, and it does not make much of an impression on him. He realizes that a certain amount of time must elapse before the bone can heal, but does not seem to realize his relation to the matter. If he is shown a skiagraph, and gets a good mental picture of the condition in his mind, he realizes just the difficulties the physician has in restoring the parts to normal and that he must not surreptitiously remove the dressings in the doctor's absence.

I well remember the case of fracture of the middle shaft of the femur. I made a skiagraph and advised the extension treatment; I was over-ruled and the limb put in plaster. This was removed in four weeks, and the leg bowed upwards by the muscles. I made another skiagraph and explained to the patient just what had happened, and why it had happened. He cheerfully agreed to have it rebroken and reset, and took the greatest scientific interest in the outcome of the case. No complaint was registered by him as he lay in bed for five weeks with an extension weight on his legs. He was rewarded with a perfect result, and still regards the matter as a "great joke on Doc". It has never seemed to dawn on his mind that he was the injured party.

He was so interested studying up on fractures that I loaned him a book on the subject. I am not sure but what he recovered the use of his limb with some regret. After he had read through the book on fractures, and re-read it several times, his respect for physicians was very

great, and he often expressed his wonder that a man could know so much. He has been one of the best friends our profession has. He will not listen to any disparagement of the doctor, but always comes to his defense with the knowledge he gained in perusing the work of fractures.

Accidents to Eyes—The great number of accidents to eyes has always been a marvel to me. Many attempts have been made to get the American workman to wear goggles while at work in the shops, but so far without results, and with the inevitable result that a great number of eyes are ruined by pieces of metal flying at a high velocity. A distressing amount of ignorance is abroad in the profession regarding injuries of this kind, nothing being done for the patient except to give a Boric Acid wash for the eye, and a sense of security is felt until sympathetic ophthalmitis starts in, when the case is referred to headquarters.

If the neglectful physician only could realize that this kind of "trusting to luck" means eternal blindness for the poor fellow, he would come out of his trance and then give the patient a chance. In this class of cases even the expert has been deceived; where an eye is under suspicion they have been in the habit of using a magnet, and where the process causes pain, 70% conclude that a foreign body is in the eye. While it is a matter of common knowledge, that many of the new high speed steels are non-magnetic, and therefore negative in this so-called reliable test. I am reminded every little while that the very men who should have this knowledge have never heard of the matter. The increasing use of these steels in the various Industrial arts, has increased the number of injuries to the eyes. The dense molecular structure of these steels makes a piece that is accidentally separated travel at an enormous velocity. In nearly all injuries to the eye by this steel, the particle has penetrated the posterior chamber and at times pushes on through the eye, and into the skull.

Reliability of the X-Ray in Localizations—From the experience gained at the present time we can say positively that any metallic foreign body can be accurately located in the eye. If three plates are made at slightly different angles, the body must show upon one of them, and if no shadow is seen out of normal, we can say positively that there is no foreign body present.

It is the only absolutely sure method of deciding this question, and any physician who fails to avail himself of the process is open to grave censure if anything happens to the eye. This I say advisedly, as I have watched a procession of patients come and go from my laboratory in the last twelve years, and I have witnessed cases of apparent neglect that have caused me to bite my tongue with suppressed indignation.

A young man only 24 years of age, who had just finished his engineering course and had gotten nicely settled in his first responsible position. While passing through the shop he felt a sharp pain in his eye, and the immediate loss of sight. An oculist was consulted, the wound was cleaned, and the man put in a dark room for several days; he then had an Iridectomy, and put back in the room. After several months he was persuaded to come to our city for diagnosis and treatment. Upon examination one eye was totally blind and the other badly inflamed. A skiagraph showed a large piece of high speed steel in the vitreous humor 3-16 long, 1-8 wide, and 1-6 thick.

The poor fellow had to lose both eyes, a life thrown away, a useful career ended, and all because a certain physician preferred to "guess" at the trouble.

We can forgive an occasional oversight, and thank the Lord, the great majority of physicians will take no chances in a case of this kind, but immediately turn it over to the specialist, and it has been the shortcomings of this individual that has attracted my attention and shows me that many of them know nothing of the help the X-ray can be to them.

THORACIC ANEURISMS.

In the X-ray, we have a reliable method of examining the blood vessls of the chest, and making an accurate diagnosis of an aneurism.

This is of utmost importance for people who have advanced to middle life, and have diseased vessels from syphilis or chronic alcoholism. Many times a diagnosis of aneurism is made upon insufficient evidence, and the patients instructed to change their occupations in consequence of the disease.

Before an examination is made by the ray, a physical examination should be made to ascertain if any abnormalities happen to be present in the formation of the chest or vertebrae. With certain children, more or less displacement of the aorta may be seen that might readily be mistaken for an aneurism.

It is seldom that a tumor appears in this locality to obscure the diagnosis, but is one of the possible sources of error to be looked out for during the examination. It is for this reason that the fluoroscope furnishes us with the best means of arriving at a correct conclusion.

If we can observe the collapse and expansion of the tumor under the impulse of the heart, we are positive that an aneurism is present. There are two types, the diffuse and sacculated form. The former may offer many difficulties owing to the broad expanse of the shadow, while the latter is easily recognized.

There is no general rule that can be given for observing them, owing to the fact that we seldom see two cases exactly the same. We usually see an aneurism of the descending aorta to the right of the sternum, above the heart, which is usually clearer, owing to its location nearer the anterior chest wall. With those of the arch proper, we get the shadow to the left of the sternum, and is usually as high as the neck, and is generally in contact with the anterior wall.

Those of the descending aorta are seen best by using the fluoroscope on the back, as experience has shown that

the diffusion of the ray may completely obliterate the shadow on the chest wall.

These examinations are usually made with the fluoroscope. The plate can be used in order to give us a chance to study the different densities, but we lose all motion in the plate, and it is by the characteristic appearance of the blood vessels, while pulsating, that clears up the doubts in a given case.

Baetjer has reported 104 cases of positive diagnosis. Hickey has referred to several interesting cases where a fatal error has followed by surgeons neglecting the evidence of the X-ray in the disease.

FOREIGN BODIES IN THE EYES.

This important subject has never received the attention it should, either by opthalmic surgeons or the X-ray operator, owing to a general want of information regarding the value of the process.

I am reminded almost weekly that some men are not familiar with the recognized methods of doing this work by reading their letters of instruction to me about making the skiagraph.

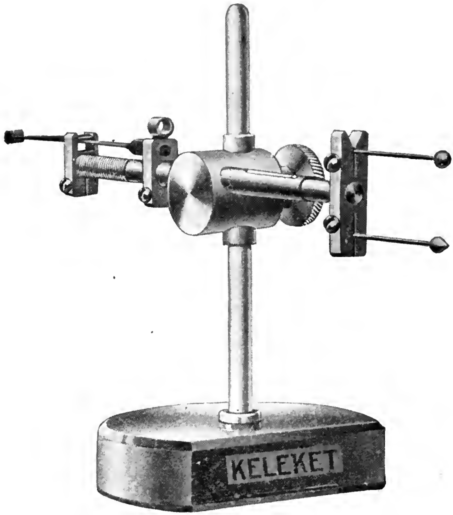
It is unfortunate that this beautiful method of diagnosis is neglected by even well known men, and operations attempted for foreign bodies in the eye, that later skiagraphic diagnosis fails to confirm, as well as a failure to find a foreign body so large as to cause wonder that its presence was not found.

A recent case was referred to me by Dr. Frank Allport, after an iridectomy had been performed by a local surgeon looking for a suspected body, and I found the end of a chisel ¼ inch long and 3-16 inch wide, behind the iris. How the original operator had escaped finding it, or at least injuring his knife, will always remain a mystery.

There are several factors to take into consideration where an eye is under examination. The original wound

of entrance, the direction and the size and probable velocity of the particle.

I have had three cases where a small piece of steel from a power hammer has not only penetrated the eye, but has passed into the cavity of the skull.



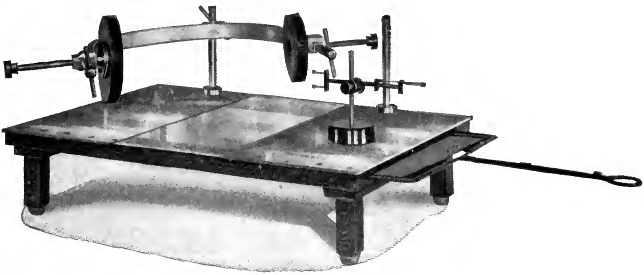
A VERY USEFUL INSTRUMENT FOR USE BY THE SWEET METHOD

Magnet Detectors—There are two methods that are fairly reliable in detecting the presence of a metallic body in the eye. The movable magnet and the X-ray.

If we suspend a very fine long magnetized needle with a very fine silk fibre and approach the eye to this needle carefully the needle will be found to rotate towards the particle if it is iron or steel. It we approach the other end of the needle it will recede and eventually turn around to point its north pole towards the metal. By approaching the suspended needle in different directions we shall find a place where it moves quickly and points to a place in the eyeball, the nearest to the foreign body.

This test is valuable as of negative value and helps to confirm a failure of the X-ray to show a foreign body as being present.

One case illustrates this perfectly well. I made three plates at different angles, but failed to locate anything that looked like a foreign body. The needle test showed one to be present, and I made the fourth exposure at an unusual angle and it showed the body plainly. This proved to be a piece of No. 30 B & S gauge steel wire 1-16 inch long. In the first three plates the pencil of rays had



SHOWING THE COMPLETE APPARATUS FOR SWEET'S METHOD AS NOW USED

hit the piece in a longitudinal plane and the minute speck was not of sufficient importance to make as grave a diagnosis as a foreign body usually proves to be.

After the body had been located by the fourth plate no difficulty was experienced in seeing it in the other three plates.

I wish I could impress upon physicians the importance of sending a case for diagnosis, rather than with instructions to make a plate of the eye. At times it can be found with the first plate, but more exposures must be made to locate it for removal.

The X-ray doesn't make mistakes but many mistakes are made by operators and those who attempt to read into the plate their anxiety, a human failing we must all guard against.

The skiagrapher has a grievance many times against his patron for the short time he is given to do his work. A case may have dragged along for a week or more while other methods of diagnosis are being tried, but when they are sent to the skiagrapher he is many times given less than one hour to do his part of the work.

We have succeeded in fulfilling the requirements of our patrons but we all think that a much higher class of work could be done with a little more time at our disposal; a number of intricate chemical reactions must have time; where they are hurried we lose much of the beauty of the process.

Methods of Localization—There are several general methods of localization. The Grossman, Sweet, Fox and numerous others. They are successful if careful attention to detail is given by the operator in individual cases.

The Grossman Method—In this procedure we make the eye furnish the necessary parallax to estimate the actual depth of the body in the eye, as well as to determine its presence within this structure.

As it is usually carried out, a small piece of fuse wire is fastened over the closed lids with a gelatine plaster opposite the pupil. The patient is laid on the table, with a proper support for the head, a plate placed under the part, and the patient directed to look down during one-half of the exposure, and then upwards during the rest. This gives us two images of the foreign body upon the plate and the distance they are apart gives us the approximate depth of the body. With careful attention to details it is remarkably accurate.

If the patient moves the head the slightest between changing the position, the apparent distance will be increased considerably leading to error. With many patients it seems impossible for them to move the eyeball without moving the head at the same time, and as the eyelids are closed the skiagrapher must take their word for it that they have done as requested, something few

operators are willing to do, considering the immense amount of responsibility they assume for an error in this class of cases.

At times it is necessary to make another plate with the eye turned in and out, and the closer the shadows are upon the plate the deeper the penetration.

While the original Grossman method called for two plates to be afterwards put together and registering the shadows, nearly all operators now use only one plate for both exposures and find it much less liable to error, as it is nearly impossible to remove and replace a plate without disturbing the patient more or less. This method has a negative value little appreciated.

If the foreign body doesn't show displacement, and it is not at the exact axis of the eyeball we know it is not within the structure of the eye.

The depth of the body can be calculated by measuring the arc of its deflection and comparing it with the known size of the eye, or in many cases the distance the shadow is behind the lead landmark over the lids.

Sources of Error in Eye Localization—One source of error in this work is the peculiar shape of the head in many people, making it impossible to approximate the plate very close to the eye. This tends to increase the distortion of the shadows and introduces a slight error in our calculations that must be allowed for in the final result, as the greater the distance of the foreign body from the plate the greater the magnification of the shadows.

Where we use the displacement caused by moving the eyes in and out during an exposure it gives us more data to calculate the apparent position within the eyeball.

Fox's Method of Localization—This method consists of introducing an apparatus beneath the lids after cocainizing the eye. A basket of fine gold wire called a "conformer" is slipped under the lids. The apparatus has an eliptical ring of gold crossed with two other wires of the

same material and made to conform to the eyeball. This divides the eyeball into quadrants.

Two exposures are made, one with a plate against the eye with the tube behind the head and the other with the plate on the temple. This is supposed to give the exact location of the body in one of the quadrants on the anterior-posterior exposure and the distance it is located from the large ring gives the proper depth. Unfortunately, it is frequently impossible to show a small particle after passing the ray through the skull in this direction. If this could be done with precision it would be an ideal method. Many times it leads to error owing to the device covering a small particle in such a way that its presence is not suspected.

The Method of Dr. Wm. M. Sweet gave us the first practical method of exact localization. He employed for this purpose a plate holder with a two ball localizer to be strapped to the head, and made two exposures by using two plates and varying the position of the target approximately 30 degrees in the horizontal position, the first exposure to be made in the same plane as the localizing balls and the second at either 30 degrees above or below the horizontal plane.

The central ball was opposite the cornea and the other at the outer canthus of the eye. When exposed in the same plane, one ball would cover the shaft of the longer staff while a dispersion of the shadow takes place when the exposure is made in a lower plane.

This method was defective for several years owing to the impossibility of changing plates between exposures without disturbing the patient.

Later Dr. Sweet improved it by introducing clamps to hold the head, localizer and plate.

The interpretation of the negative offers considerable difficulty, owing to the necessity of charting the eyes, still it can be done with a little practice and with remarkable accuracy. One source of error that can scarcely be avoided in a nervous patient is to keep the eyeball ex-

actly parallel with the two indicators and at a known distance from the cornea.

Burdick Method—I have used a modification in my practice of the method of Drs. Sweet, Fox, and Grossman. My indicator is upon a special stand and is easily adjustable to any position. In doubtful cases the ball is usually placed in the outer canthus, then is swung upwards under the superciliary ridge and one exposure made by the Grossman method. This gives us a very accurate location by charting the plate. This may be done on one plate, but in all doubtful cases at least three plates should be made, with the localizer in three different positions.

The first plate is made according to Sweet's technic, the second according to Grossman's method with the localizer still in place, and the third with the localizer at the outer canthus during a part of the exposure. Then under the superciliary ridge and at times an extra ball used at a line intersecting the upper one with the central ball. This gives us five points to chart our location, and it has been found very reliable in practice.

The financial part of the process has been one that is not always understood by the Doctor. While some of the approximate methods do not consume more than one or two hours' time exact localization may require as much as three hours' time, one plate being developed as exposed, platted, and then more exposures made in the light of knowledge gained.

Occasionally we are called upon to find other foreign bodies than steel or iron, many eyes being injured by glass or cement, and many eye surgeons do not know it is many times possible to locate these bodies as well as steel. Where we are called upon to do this work we replace our localizer with a particle of glass or cement from the same source as the original particle was derived, and by regulating the vacuum carefully, we gener-

ally succeed in showing the foreign body without much trouble. The density of the shadow given by the localizer gives us a guide to read our plate.

Many other men believe they have succeeded in devising methods more reliable than the ones described above. They are a matter of record for those especially interested and no special reason exists why I should tire you with them. In passing we might remark that there are many brilliant ideas in some of them and occasionally we have to use some of their special features where we have a case that presents an abnormally shaped head.

THE X-RAY AS THE CAUSE OF STERILITY.

This disquieting fact was borne in upon many of the earlier operators, by the sudden termination of an increase in their families. The cause was not suspected for several years, until an opportunity to compare notes was found at one of our annual meetings, when the trouble was found to be well nigh universal.

Animal experiments were made to determine the effect of the X-ray upon this function, and it was found to be a fact that the X-ray invariably produced sterility. The semen of various operators, hired help in the factories, were examined, with a view to settling the question. In all, I have a complete record of 84 cases of individuals who have been intentionally associated with the X-ray, as operators, mechanics, salesmen, stenographers, where I have been able to follow their history, and as far as I have been able to ascertain, each one, both male and female, are perfectly sterile. Some of them were young men and women just in the prime of life, who were interested in some way with the use of the X-ray. They have since married, and no issue has resulted. Many of these cases have been married for ten years. In quite a number of men, I have examined the semen and found an aspermatizoa. Several of the women have married vigorous, healthy men, and have had no issue, much to their distress.

Animal Experiments—In order to determine just what the factor in the case might be, a series of exposures were made upon guinea pigs, who had established a record, before they were selected for the experiment. A very prolific female was submitted to 90 milliampere minutes, given in fractional doses at intervals, with a tube absorbing 25,000 volts. No injury was suffered by the animal, yet she remained sterile for one year, she being killed by accident. This was repeated with several pigs, with the same result.

Next, the male pig was put under the influence of the ray, he getting the same amount, and turned loose with a number of females. He also seemed to be sterile. He was given six months, and then removed, and an unexposed male placed in the cage, when business was immediately resumed as usual.

It seems to me that the result is due directly to the effect of the X-ray and that both sexes are affected alike. No effect has been noted upon potency in either the animals or upon human beings, so far as can be ascertained, some operators and mechanics claiming that a greater desire has been the result.

Numerous experiments have been made upon eggs and the seeds of domestic grains, where the results were claimed as positive. A fruitful field for experiment can be worked, as certain factors entered into the series of experiments. that leave them open to question.

Eggs that have undergone a long journey before being used, might not generate. To say nothing of seeds obtained under city conditions, if some of our country physicians will take up this work, they will confer a lasting benefit to science.

The effect of the ray should be noted upon sprouting seeds and growing plants, and the results carefully noted.

THE EFFECT OF THE X-RAY UPON BACTERIA.

A great number of experiments have been made by different bacteriologists upon the effect of the X-ray upon

bacteria, and as usual, with widely different results, many of them being hard to understand.

Davis, Keen, Nuhsam, Wittlin, Sormain, Grumach, and many others, failed to note the slightest effect upon bacteria. Minich found that Typhoid culture on Ager plates, exposed to the rays for 30 minutes were not killed, but fewer colonies developed in the exposed part.

H. Rieder refers to the experiments of Schultze and Beck, where it is shown that the X-rays do not change the chromogenic effect of the micro-organisms.

Wofenden and Ross noted that a culture of the Prodigiosis on potatoes grew rapidly when exposed to the X-ray. Zeitz' experiments were negative.

Rieder, by accident or more knowledge, succeeded in producing a profound effect upon the various Bacteria as the cholera Vibrio, Staphylo, and Streptococcus, Bacillus of Anthrax, and the Tubercule bacilli. He exposed Petrie dishes with a lead cover, and a peculiarly-shaped aperture, and found that the exposed plates showed a diminished number of the colonies. He experimented upon animals, as mice, rabbits, and guinea pigs, but found the results negative, and came to the conclusion that the X-ray was without results in germ infection.

With chronic infections he was more successful. He subjected the pigs inoculated with tubercule bacilli to a destructive action of the X-ray, until vesication took place, forming ulcers upon the skin. He found that the disease was retarded, and a certain amount of encapsulation of the foci took place. It was his idea that the X-ray would inhibit the growth of germs in the body, this being all that might be necessary to successful therapy.

These experiments of Rieder's are of great interest for several reasons. First, they show that he, by a combination of circumstances, obtained just the right radiation to affect Bacteria. Second, in his experiment on animals, the extensive destruction of the skin showed that the apparatus as used by him gave out a great volume of soft

rays, of a low degree of penetration—rays that in all probability were absorbed by the skin and did not reach the lower structures. Third, as all the animals showed marked improvement following exposure, but later died, is it not reasonable to suppose that the extensive X-ray burns produced had much to do with their death? Those of us who have witnessed the pain, exhaustion, and toxemia following this injury, will have no difficulty explaining why the animals eventually died.

His general conclusions are well taken. He says that bacteria, when grown on agar-ager, blood serum, or gelatine, could be killed when exposed to the X-ray for an hour or more; that their development could be stopped when grown upon a suitable medium outside of the body, by exposing them to the action of the X-ray for a certain time, and maintains that it is not necessary to kill the various bacteria in the human body, but merely to inhibit their growth.

In another experiment Rieder used dishes of beef-glycerin with peptone solution, sowed with a thin layer of a tubercule bouillon culture. He exposed four dishes for an hour, and placed them with the control dishes in the incubator. In one week, he obtained a luxuriant growth of tubercle bacilli in the control dishes, a much diminished growth in three dishes that were slightly exposed, and scarcely any growth in the fourth dish. This has been confirmed by Jacinsky, and many times by myself.

I commenced on a long series of experiments with the Protozoon, and ascertained that under favorable conditions, they would live through 275 generations, thus confirming Gaylord's work in this line. When we have reached this point, they will die out, if left to themselves. If, however, we sensitize them with a diluted salt solution, they recover their normal vigor, and will again reach nearly the same number of generations before their existence is terminated. We can sensitize them several times,

but with a shorter interval between, until they will eventually come to an end.

If we expose the culture to a radiation of a very low amplitude, such as is obtained from a proper coil, with the tube just above the line where the X-ray is given off, and with a tube distance of 3 inches, in order to keep well within the limits where the positive disturbance called the alpha ray is given off from the tube. We will find that an exposure of 90 milliampere minutes, using 12,000 volts in our secondary, which would give us about one kilowatt of energy, will terminate the growth not at the time of exposure, but about 18 generations after the exposure, and it has not as yet been found possible to resensitize them to further growth, so that it must be clear that the effect of the ray is upon the individual cell, and has some ill-defined action upon the vegetative function of the cell that has a serious effect upon their successors.

Many hundreds of these experiments have been made, careful records being made of the actual amount of energy absorbed by the tube for comparison purposes. It was further observed that a tube absorbing about 1,500 watts was fatal within four generations. There is one logical fact, that many experimentors have not grasped, where the X-ray is absorbed by the part profound retrograde metamorphic changes are induced. Where the ray is transmitted through a part, we get a stimulation of cellular activity. When this principle is thoroughly learned, we may expect a competent Biologist to settle many of our problems, and not before.

Much original work has been done by Kenyon Dunham, and many successes have been reported; while his earlier work was negative, his latter experiments have been successful in demonstrating a profound effect upon Bacteria.

There is a fruitful field for original work along this line. It is seldom we can find a competent Biologist, who has a good working knowledge of so complex a study as

the X-ray, and the proper facilities to carry on original work at the same time.

SKIN DISEASES.

Mycosis—This rare but disgusting form of cutaneous trouble has always been a difficult proposition to the dermatologist as a great number of cases have persisted for many years. I have been fortunate in attracting eleven cases of this trouble, eight of which were promptly cured, three cases not taking more than a few treatments and becoming dissatisfied or discouraged, stopped coming. A number of these had large suppurating tumors of the papillomatous order, extremely painful and creating considerable systemic disturbance, owing to the absorption of toxine. Five of these recovered promptly under the X-ray treatment alone. Three of them it was necessary to give a sensitized iodide of potash solution in full doses, the sensitizer used being uranine in half grain doses. This is an analine derivative. These large suppurating masses disappeared rapidly after the solution was used, although little or no effect is produced upon the growth without the ray treatment. Many times it is difficult to treat these cases owing to the diseases being located in an inaccessible part of the body, and consequently the treatment must cover a long period of time in order to prevent too much injury to the white blood corpuscles from an excessive amount of ray. It is not practical to treat more than fifteen minutes daily for any length of time, or an anemia will be produced that is exceedingly difficult to overcome, and it is probably the explanation why the ray sometimes has a bad effect upon the disease rather than a good influence, the vital processes being arrested, perverted or destroyed by too much ray. More investigation is needed upon these lines by some physician who has time and inclination to use the microscope for original research.

Mycosis Fungoides—This affliction deserves a classification by itself, as it has a clinical history at variance with the ordinary mycotic infection. This disease is accom-

panied by an acute eczema, excessive itching, and more or less maceration of the superficial skin, with large moist tumors, which are extremely painful.

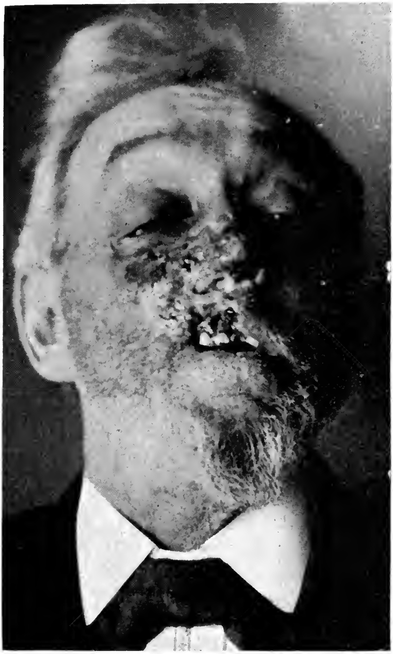
One interesting case gave on culture, Klebs-Loeffler bacilli, staphylococci aureus and no fungi. Still it had the appearance, and clinical history of a typical case of fun-

LUPUS ERYTHEMATOSIS CURED BY THE X-RAY

goides. It had been so diagnosed by two eminent dermatologists, who practically advised the patient that it was incurable. She had had the disease for four years and several times the tumors had been removed by surgeons, but with a prompt recurrence.

Her condition was deplorable when she first called. Over ninety tumors upon the body varied from a hazelnut to a tumor the size of an adult's fist. Four months previously some dermatologist gave a strong chrysarobin

ointment which destroyed the tops of the tumor and started all of them suppurating, and when she presented herself she was so weak she could not walk without assistance. She was given an injection of diphtheria antitoxine and streptolytic serum and put upon the X-ray treatment, and in eight weeks all the tumors disappeared



LUPUS VULGARIS CURED BY THE X-RAY

except one, when she concluded to go home and continue the treatment. There apparently something went wrong, as a prompt recurrence took place and she had to be brought back to Chicago again. In six weeks they all disappeared and she remained free for one year when a slight

recurrence took place in the axillary space. It again yielded to a mild application of the ray and considerable curiosity is manifested as to the outcome. She is in excellent health at the present time.*

I have had five other cases of mycosis fungoids with all of its typical symptoms, which yielded promptly to the ray treatment with no recurrence. I believe it may be relied upon absolutely to cure any case that may present itself. This is based upon too few cases, however, and no assurance should be given of a cure. It should not be forgotten that a few cases have recovered by full doses of arsenic and salicylate of soda alone, although all of my cases had had it for months without any improvement in the symptoms. It certainly is a good illustration of the marvelous healing power of this mysterious radiation, to see tumors of this character break up and disappear in a few weeks, leaving no trace behind them. Nothing analogous has ever been known in medicine. The results seemed so "bizarre" in the beginning that no X-ray operators have had the courage to report them out of X-ray circles, and it is only after these results had been verified by hundreds of other operators that any report has been made to regular medical journals for the benefit of the profession at large.

Epithelioma of the Skin — The experience with this type of cancer is very great, and the results have been verified by thousands of operators and in all parts of the world. My personal experience has been extensive in cases involving all parts of the body, and has led me to the conclusion that the X-ray when properly used will cure any case of skin cancer not complicated by metastases or extension into the deep tissues. Some cases present immense difficulties, and necessitate many changes of technic before favorable results are obtained. In one case of this character a large, thick ulcer upon the malar bone would improve temporarily and suddenly get worse. He

*She died March 16, 1909, from a rapidly growing carcinoma of the leg starting from an old scar.

was treated at intervals for six months and still showed an active ulcer when I began to send the ray through one-sixteenth of an inch of aluminum, and in two weeks it healed up, and has remained so. Aluminum acts as a step-down transformer and at times seems to change the rate of oscillation to a period so that the tissues may absorb it. I have found two varieties of epithelioma, one of the lip and the other involving the deep structure of the nose, that will not respond readily to X-ray treatment. It will check the growth and hold it as long as the treatment is continued, but extensive infiltration may take place sooner or later. A few cases of this character yielded promptly, seemingly responding to the ray as well as more favorably situated growths, and it might be well to leave growths upon the mucous tissues to the surgeon until our technic has been improved in such a way that favorable results can be predicted. A recurrence is almost certain to take place after its removal and can be prevented only by X-radiation given early after the operation, and then a fair assurance of success may be looked for.

Cancer of Orbit—Several cases involving the structure of the orbit have recovered under the ray without endangering or destroying the eye, but ordinarily are not suitable for the surgeon or the X-ray operator, as they are rapidly growing and very destructive. The X-ray will check its growth and can hold it for months, but can rarely be depended upon to destroy it, although rendering the patient free from pain. All other skin cancers should be treated for a time by the ray before any attempt for its removal is made. At least one good dermatitis must be produced, and if cicatrization does not take place, removal may be advocated, and great assurance of success be entertained. It is evident to many operators that great improvement in the technic is possible and when this is accomplished it is their belief the X-ray will be found all that could be desired in this class of diseases. The greatest difficulty is experienced in one case in about thirty, the others pursuing a perfectly typical course under the

ray treatment. Citcatrization takes place readily in from six to twelve weeks, depending upon the size of the lesion. Where metastases have formed they should be turned over to some good surgeon and rayed soon after operation. The technic required to treat superficial and deep lesions at the present time is too much involved to justify any operator without enormous experience to treat them. When we get some suitable method of measuring the chemical value of the ray these difficulties will disappear. More failures at present are due to the fear of producing destructive action upon the tissue than any other cause. Care should rightly be used as a chronic and destructive X-ray burn is very painful, and undesirable for medico-legal reasons, and until the medical profession can be persuaded to let X-ray burns alone and allow the operator to treat them, we must expect trouble with X-ray treatment. Vaseline, antiseptics and irritants of all kinds will turn a simple dermatitis into a destructive X-ray burn, and the sooner that physicians realize that an X-ray burn is different from anything they have ever seen in their lives and let it alone, the sooner we will have less damage suits to contend with.

Epithelioma of the Lower Lip is usually complicated by metastases in the submaxillary gland, even when no enlargement can be located. It seems the part of wisdom to remove all of these glands very early. As far as primary epithelioma is concerned it will not generally yield as readily to the X-ray treatment as more favorably situated cancers, but at least 40 per cent will yield readily, but recurrences are common. This is also true of operations upon this form of cancer.

Sarcoma of the Skin—I have been peculiarly fortunate in getting a great number of this form of skin troubles. I have treated eighteen cases in the last five years and in general, have had good results. The technic involves the use of a medium tube or a spark gap one-half inch each side of the tube if the low skin tube is used, and as much treatment given as is compatible with the safety of tissue.

No dermatitis should be produced as the disease takes on a growth immediately. I had one notable case referred by a physician here, of a young man of seventeen years who had a primary round cell sarcoma of the upper jaw, which was not diagnosed correctly for some time and an operation attempted. Immediate multiple sarcoma appeared all over the body estimated at about 2,000 in number, the patient showing a peculiar cachexia and not in very good health. I began to treat the more rapidly growing ones and a quick disappearance took place. He was under treatment for five months and all the sarcomas had disappeared except two, which had shrunk so they were scarcely visible. The primary sarcoma had diminised over two-thirds in size, but some exuberant granulation had formed upon the lower jaw which bled freely. He was persuaded to visit one of our noted surgeons who commended the work highly; recommended an operation upon the mouth. The patient consented; the operation was followed by acute sepsis and death took place in 26 hours. Improvement took place steadily under the treatment for three months, and then seemed to stop, and Cooley's toxin was used, in a few obstinate tumors and they immediately disappeared. The value of this remedy can not be overestimated in this disease, as it will cure many cases with the X-ray that will not respond to either treatment alone. Considering the hopeless prognosis usually given these cases and the acute suffering that a patient endures with a round cell sarcoma, the result should have been favorable. Certainly death was farther from my mind than recurrence, but his life was terminated by an untimely operation.

In six cases I was bothered by new metastases occurring in different parts of the body, necessitating constant watchfulness that they might be treated on appearance. Eventually success seemed to have been obtained, as no new growths have shown up within the last seven years. I have had five cases of spindle cell sarcoma with multiple metastases where the latter disappeared rapidly and the

former appeared scarcely affected, resisting stubbornly both the ray and the toxins and each separately, death taking place at intervals of from one to three years, seeming from some cachexia undermining the patients' health. Seven cases of sarcoma with metatases and some primary comprising three melano-sarcomas and four round cell sarcomas have made a rapid and uneventful recovery. Four of these cases are now free from recurrence for eight years and the patients never felt better in their lives. It occurs to me that success could be obtained in a great many cases of skin sarcoma if the technic were more thoroughly mastered. All operators have had the experience while treating these cases to see their progress suddenly arrested and the tumor begin to grow under the treatment, and they have reversed the process by simply changing the tube to new one or causing the ray to pass through some absorption layer before coming in contact with the tumor. It leads me to believe that sarcoma tissue can only be destroyed by "ray waves" within narrow defined limits. Many tubes simply stimulate the growth, while others are deadly both to the sarcoma and the normal tissue, while a few give off rays that affect the sarcoma tissues alone, causing an atrophy and degeneration of its cells, while connective tissue gradually takes its place.

Repeatedly sections of a "rayed" sarcoma have been made and all of the well known marking absent. These results have been verified by many conservative operators in different parts of the world, and no conscientious operator should hesitate to use the treatment for this admittedly hopeless condition. Careful observation of the technic should be made and the results compared with other cases in order that the secret may be learned. Why one case rapidly recovers and another rapidly grows worse, both apparently suffering from the same trouble, given the same treatment, and still the results are identically opposite. Also he should try and learn why a slight change in the tube or technic will favorably influence a

bad case and make the good one take on a more unfavorable aspect. There is a fact concealed in this problem that stands between the operator and his patient, and when it is learned we may expect sarcoma to yield to X-radiation as readily as the ordinary eczemas. Operators should not be discouraged by reports emanating from alleged scientific observers who believe that the X-ray is merely the X-ray and uses the same technic for all so-called series of cases. The conception is almost as unscientific as sitting down upon the keyboard of a piano while attempting to play Chopin's Funeral March. When we attempt to eliminate errors from our work it should be our aim not to introduce more by "straining at a gnat and swallowing a camel."

Senile Keratosis—This obstinate trouble of old age which frequently precedes epithelioma has been found to yield very readily to X-radiation, and no other satisfactory treatment is known for this condition. The X-ray should be used exclusively, as it seems to be a specific for this trouble.

Condylomata—In the X-ray we seem to have a perfect method of handling this disgusting venereal disease. I have had 23 cases of this trouble and have never failed to get a very prompt and satisfactory result; and it is vary rare when we have to produce a dermatitis to cause the absorption of the masses.

In the case shown the whole vagina was distended with the growths, and the discharge was very offensive, and persisted until the fifth treatment when it disappeared.

Trachoma—The X-ray has been found very reliable in this disease. Several cases have been reported by Eberhard, Krell, Newcomet, and Coleman.

The fear of injuring the eye is remote, owing to the fact that the eyes will stand thirty per cent more rays than the skin. As a general proposition, some of the special forms of tubes are better for this condition, as we can put them in contact with, or very close to the lids, and get a very narrow field of active radiation. This is a

boon to these poor people, as few physicians realize how much misery and suffering is caused by this condition.

If you are quite expert with your apparatus, about four treatments are all that may be required. New beginners had better go rather slow until all conditions connected with this treatment are well known to them.

Albert C. Geyser reports in the Journal of Advanced Therapeutics, May, '04, eighteen successful cases of granular lids as being successfully treated with the X-ray.

He says the chief aim of the treatment is to check the development of Hypertrophy of the conjunctiva, and to bring about the absorption of the granulations in order to prevent the destruction of the mucous membrane, and to reduce the previous destruction by the disease to the least possible condition.

To cause absorption and stimulate normal nutritive process, he recommends the High Frequency electrode.

He everts the lids, and after anointing them with vaseline, attached a strip of adhesive plaster, with a lead weight upon the lower lid. He uses a diaphragm in order to protect the normal tissue during the exposure.

He has not observed any damage to the eyeball, but suggests that the tube not be brought nearer than six inches.

After he has given six or eight treatments in this manner, he substitutes the High Frequency for the X-ray, for a three or four-minute treatment daily, care being taken not to cause irritation. This is to be continued for three or four weeks.

The eighteen cases reported were taken at random, some being private, some from institutions, and others being referred.

Glandular Enlargements—The general action of the X-ray upon tumors of the lymphatic system is favorable. The nutrition is remarkably influenced, and they are rapidly destroyed and broken down under full doses of the X-ray.

Tuberculosis of the Glands—The remarkable effect of the X-ray upon a purely tubercular infection is educational; as a general proposition, a recession of the swelling takes place, and in a few weeks the gland has disappeared.

Eberhard claims as high as 60 per cent of cures, and I believe this is altogether too conservative. While my personal experience has not been as extensive as his, being limited to 45 cases, my percentage of good results will run as high as 70 per cent.

Eberhard insists the X-ray should be given a thorough trial before an operation is attempted, and in this I cheerfully agree. The fear that the disease would spread by the absorption of the tumor has proved a groundless fear, as it has done so in no case that has come under my observation.

If fluctuation is apparent, it calls for prompt drainage, but physicians should begin to stand upon their own bottom, and not allow the Surgeon to do all the thinking for our profession. This individual is a handy man to have around and to fall back on occasionally, but he has about come to the conclusion that he is the profession. There are many methods of treating diseases and getting results without resorting to surgery, and it would seem that the time has about arrived where the Surgeon took his proper place as the adviser and helper of the physican, and not as the dictator of all medical thought. There has been altogether too much operating upon this class of cases, and it is about time the profession learned that there are many ways besides anatomical dissections for their cure. And all Physicians should know that surgery has been a miserable failure in this class of diseases. Recurrences are the rule and not the exception. It has excited no comment in my laboratory to have people present themselves who have undergone as high as six operations for infected cervical glands, and yet they had sinuses discharging great quantities of pus. I have observed these

same cases recover rapidly under the X-ray treatment, and be discharged well in a few weeks.

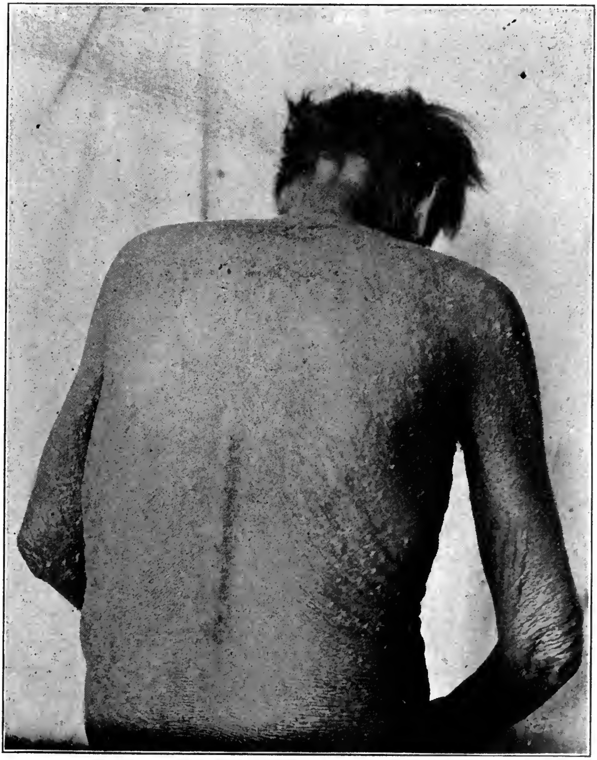
SKIN DISEASES.

Technic—Reduce the tube carefully below the line where it will give off X-radiation in series with the machine. Insert spark gap of a quarter of inch each side of the tube. Place glass walls of the tube five inches from localized trouble. Use a mask of lead; give five minutes exposure every other day for two weeks and continue

ECZEMA OF THE HAND

every day until irritation is produced. Use one milliampere of current, stop treatment as soon as a pronounced itching sensation is produced. Most external lesions of the skin require the tube at 15 inches, one-half inch spark gap, two milliamperes of current and eight minutes exposure, with no protection of the parts. I shall give my

attention to describing the skin diseases that I have found in eight years' experience with Radio-therapy to yield readily to the X-ray. This experience as I shall give it, will be a personal one. I shall not attempt to give credit



A BAD CASE OF PSORIASIS

to anyone for priority of suggestion. I am not insensible to the immense amount of work done by others in this line of treatment, and have adopted and used any good suggestions that appeared from time to time.

Skin diseases have offered great difficulties to the general practitioners and dermatologists had a great number of skin troubles that resisted every effort they could make and a great classification of obstinate diseases were not considered curable up to the discovery of the X-ray.

When it was found that the X-ray had a peculiar curative property in this line of diseases, it met considerable unbelief among dermatologists and physicians who had tried to treat these diseases in years past, and all of the early work of the X-ray operators was discredited in the medical mind as being the result of a "hypertrophied imagination."

Time, and the increasing number of cures, however, soon compelled wonder where ridicule had been the order of the day. I well remember the plight of an early operator who read a paper in the American Roentgen Ray Society on localized tuberculosis and the amount of ridicule and abuse he was compelled to stand. The society excluded the paper from the public proceedings. One year later the society had four papers on the subject which were favorably received and discussed by the many members present. There is only one drawback writing upon this subject, and that is the danger of exaggeration. A writer may be pardoned if his enthusiasm runs away with him when he is writing about some well-known subject, but greater danger may follow unwise assertions.

Inflammatory Dermatosis—My experience with this class of diseases has been uniformly successful. Eczemas of the various parts of the body yield readily to the proper application of the X-ray. The chronic indurated eczema of the hand appearing among seamstresses, milliners, etc., will heal up readily in a few weeks under the influence of the ray. Many of these cases of many years standing where all other forms of treatment have failed, yield as promptly as more recent cases. The effect is not limited to the relief of a patient, but there is some change in the tissue that causes a complete disappearance of the disease. There is a disposition among operators to regard this

treatment as a specific in eczema, but a number of failures have occurred among some of the most skillful men.

Psoriasis and Lichen Planus are two different diseases that yield readily to X-radiation. Healing starts promptly and all evidence of the disease disappears after a few weeks' treatments. I have had 58 cases of this character, and satisfactory cures have taken place among all of them.*

Rosacea—The follicles and dilated blood vessels disappear rapidly, followed by a rapid retrograde tissue change until in a few weeks, the nose assumed its proper size and shape. A very slight tendency to relapse could be noticed in several cases, but have yielded promptly to the farther application of the ray. It is hard to realize the gratitude of the victim of this disease when he finds that a cure has taken place. To be always under the suspicion of looking "upon the wine when it's red," when you are a prohibitionist, is heartrending. I have had 32 cases of this trouble and good results have been obtained in each instance.

Hyperidrosis—This little, but aggravating trouble causes considerable annoyance to the victim. The clothes are constantly soaked in perspiration in places, and usually considerable odor accompanies the disease. From the well known action of the ray upon the follicles of the skin, it suggested itself early to several operators as a remedial agent of great value. Experience shows that their inference was well founded, as a prolonged application of the ray will cause atrophy of sweat gland to take place, and a cure is obtained. Eberhard has observed that the ray does not have the same relative effect upon the sweat glands as upon the hair follicles and sebaceous glands, but has proven quite efficacious in relieving the hypersecretions due to the over-activity of the former. It is the only known successful method of treating this troublesome

*Many recurrences were noted among them in late years.

complaint. I have had 27 cases of this trouble and few failures. It apparently is a specific for this class of diseases.

Pruritus—Apparently we have in the X-ray a reasonably successful method of relieving these pitiful sufferers. The horrors of this disease can hardly be imagined by those who have not been compelled to put up with this intolerable itching night and day, with no means of relief. Their suffering is so great that they will tear their flesh with their fingernails to get relief.

One patient I had with pruritus ani could only sleep while lying in a bathtub containing baking soda and water. The trouble seems to be due to a peripheral neuritis, and the effect upon the terminal nerves by the X-ray suggested its use to this condition, and immediate relief was experienced. It is necessary to carry the exposure far enough to produce a very mild form of dermatitis to insure relief. I have had 62 cases of this trouble in the last twelve years and relapses have occurred in only four cases which readily yielded to further application of the ray. Pennington has reported several successful cases of this trouble.

Indurated Eczema—This disease disappears rapidly under the ray treatment. As a general rule no other application should be used for these cases except the X-ray and particular attention should be used to get just the right kind of a dermatitis.

If the ray is pushed too far these cases react violently and destruction of tissue may take place. It should be borne in mind that nearly all cases treated by the X-ray operators are chronic and have existed for years and had treatment from physicians and then had been treated without avail by some of the most noted dermatologists in the world, and the fact that we can cure these diseases in a few weeks shows the enormous value of the ray as a curative agent. The success that has followed its use makes it desirable that this treatment be continued to the

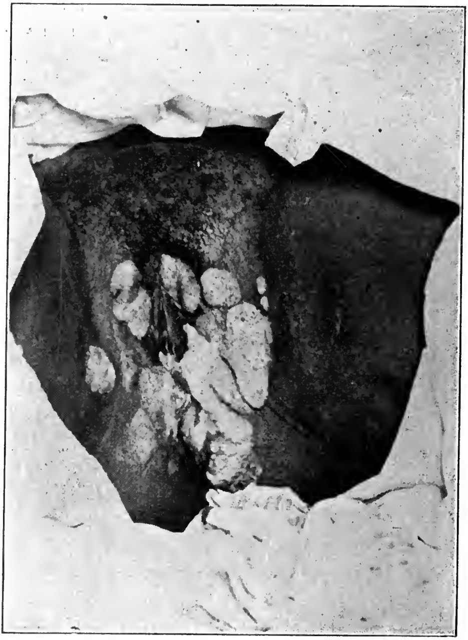
exclusion of other forms of treatment until sufficient experience has accumulated to allow us to form a definite rule for its use.

Pigmented and Vascular Nevi—This ugly ailment which causes so much mental distress to its owner can be improved, and in many cases removed entirely by the X-ray. I have had to deal with twelve cases of this character and while I did not succeed in completely removing all of the marks, it bleached out to such an extent that it did not annoy the patient to any degree. Many times a deep, angry red would bleach out to a pale pinkish tint, not at all noticeable. In several cases I have supplemented the ray with a zinc-mercury needle that destroyed the large vessels that supplied part of the nevi, thereby hurrying the process several weeks.

Hypertrichosis or superfluous hair has not given quite as good satisfaction as it promised in the beginning. The hair may be quickly removed but promptly returns without the exposures have been carried to the point of vesication where the hair glands are destroyed. Many cases of rather severe dermatitis are sufficient to prevent a recurrence, but cannot be depended upon without repeating the exposure in four and ten weeks to supplement the effects of the ray. This method of treatment has not had a fair show, as those presenting themselves with this trouble are women who have a growth of hair upon the face and very few operators care to run the risk of scarring a woman's face, even if he doesn't consider it beautiful, as the woman is sure to disagree with him. I had one notable case of a girl who intended to get married and had a "skeleton in her closet" in the shape of a patch of stiff black hair about six by eight inches located between her breasts. I undertook the task of removing it by the ray and succeeded in doing it in four treatments, which were supplemented four and ten weeks later with more treatments to prevent its return. I am glad to say that I was entirely successful, as no recurrence has taken place in four years. It seems absurd, but no one could be more grateful than this patient, even

if their life was at stake. Farther investigation is demanded upon this subject, and it should be invariably treated where the hair appears upon the body.

Acne—In this disease the X-ray can be considered as a specific. In over 80 cases I have no failures to record. It is marvelous the way acne will yield to the proper appli-



CONDYLOMATA VENEREAL CURED BY THE X-RAY

cation of the X-ray. We seem to get just as good results in the indurated acne of ill health as we do in the acne of healthy children. The result is due to the direct effect of the ray upon the follicles of the skin. They decrease in size, the oil disappears, and a general improvement in the

texture of the skin takes place. Of course, it should not be necessary to say that a treatment of this kind requires considerable caution and it is usually prolonged for safety as no risk should be run run of scarring the face where it can be avoided.

LUPUS VULGARIS.
FOLLOWING A GASOLINE BURN

Lupus Vulgaris—This is disease surprised every dermatologist by the way it would yield to the X-ray. I have had 68 cases of this disease and only eight failures to record. One was very extensive; covering both sides of the face and neck and complicated with syphilis. An operation upon the mastoid by some surgeon in the county hospital resulted in a tubercular meningitis. While this case was under treatment one side of the face and neck cleaned up beautifully and the surface upon the other side had become circumscribed and a favorable result was looked for when the mastoiditis rendered

an operation necessary for relief. I have had so many cases of this disease that I have had a fair chance to try the ray in all of its various phases, and have come to the conclusion that the ray is specific in any uncomplicated case of lupus vulgaris. Many of the cases I have treated have existed for years; have tried all forms of treatment, and still existed in all their hideousness. It would seem from the number of favorable reports received from different operators that surgeons would hesitate before skin grafting, curetting or cauterizing the surface in a vain attempt to relieve the condition. But it seems it is just as common and just as much in vogue at present as before the discovery of the X-ray. Surgeons either will not believe or are ignorant of the help this great curative agent can render them in treating this form of disease. The result is that many of the cases are complicated by mixed infection, due to operative measures undertaken for their relief. If medicine had as satisfactory an agent to treat other troubles as the X-ray has proved in lupus, it would be very fortunate indeed.

Lupus Erythematosum—This disease has given the profession trouble for many years. It is always doubtful what course a disease of this kind will pursue. It would seem that the X-ray should be indicated, but experience has shown that only a few cases will react satisfactorily with this form of treatment, many taking on a more violent form. It is impossible to give a patient any encouragement, as no one knows just what a given case will pursue. It seems to be the general concensus of opinion that the disease will react to the high frequency current and the Finsen light or some of its various modifications. Good results have followed the use of a blue glass screen over a powerful arc light. A few cases will resist every means at our command. Occasionally good results have been obtained by passing the ray through one thirty-second of an inch of aluminum before it is allowed to act upon the diseased area, as the metal acts as a transformer of the ray, sorting out all the alpha rays, which, being electrical

in character, causes a succession of rapid condenser discharges. These oscillations have a nutritional effect that is very marked and frequently will turn the scales of an unfavorable case to one that will react favorably to the X-ray.

Farther experience with this disease is necessary, as it is believed by all operators that the trouble should yield to the X-ray treatment and it is the general opinion that the technic is at fault. The remarkable way some cases react to the ray shows that a favorable influence is exerted upon it, but the puzzling part is the resistance offered by other cases of apparently the same character. Several obstinate cases of this disease yielded to the ray treatment only when supplemented with potassium iodide solution in 20 gr. doses, although this drug would not influence the course of the disease in the slightest without the ray. Painting the surface with eosin solution before raying, has seemed to act favorably in two cases, but all methods are so seemingly open to question that it cannot be said to be upon a scientific basis. It is probable that a scientific method will eventually develop from the accumulated experience of different men.

Tinea and Sycosis—The X-ray may be considered a specific in these troubles. Eberhart claims 90 per cent cures, with few relapses, which yielded to farther radiation. Many cases will yield to the ray that have resisted other methods of treatment for many years, and as far as I have been able to observe, the results are permanent, as I have thirty-two cases that have been well for over six years, and as many others that have been free from trouble for a shorter period of time. It is rarely necessary to produce a dermatitis with this trouble and several cases have got well with four exposures, although it is generally necessary to go more carefully as a safety measure. I have had several cases of severe sycosis upon the face that produced a hideous appearance and had resisted treatment by several well known dermatologists for a number of years. Great difficulty was expected with the X-ray treat-

ment, but to the surprise of both patient and operator, they offered as little difficulty as minor cases.

Keloids and Scar Tissue—A surprising effect is noticed from the use of the X-ray upon growth of this character. A retrograde metamorphosis is noted immediately and ordinarily a steady shrinking takes place, leaving a flexible, colorless scar tissue behind it. The pain disappeared shortly after the treatment had begun and the result seems to be permanent. Occasionally the retrograde process seems to be arrested before a complete disappearance of the keloid takes place and a slight elevation may remain. I have noticed this effect in two cases. It would be more desirable if more of these cases presented themselves for treatment in order to increase our experience and work out a definite technic. I had one distressing case of this character; a beautiful young woman who was thrown from a horse and her face came in contact with a barbed wire fence, cutting her cheek from the corner of her mouth to a place just below the ear. A good union was secured but the scar took on a keloid growth and reached a large size. It was removed three times but promptly recurred and at the time she presented herself for treatment, it had obtained a growth of one inch the whole length of the scar. Treatments were begun cautiously and in two weeks distinct improvement began which continued until a level of the true skin was obtained. When the treatment was suspended no recurrence took place in five years.

SARCOMA.

Radiotherapy in sarcoma has an established value. So many cases have yielded to this method of treatment in the hands of different men, that enthusiasm can no longer explain the results.

It is a fact that sarcoma tissue is destroyed by the X-ray and replaced by a colloid degeneration, or a connective tissue growth in place of the malignant tissue. Of course it should not be looked upon as a specific in this

disease, as it has not proved to be. Moreover it should be understood that 90 per cent of all cases of sarcoma treated by X-ray operators were considered both inoperable and hopeless. The X-ray being used only for its analgesic properties.

This disease should properly be divided into three classes for consideration from an X-ray standpoint. First, as primary cases offering some hope, second, as received following operations, and third, as cases inoperable and hopeless so well known to the profession.

It is among the primary cases that we must look for the greatest value of the X-ray treatment. Many primary cases of sarcoma will yield favorably to the ray treatment if properly applied. In many cases the tumor will disappear and no recurrence take place, and in the great majority of cases the growth is checked, pain relieved, and as far as the patients' feelings are concerned they consider themselves cured after a period of quiescence has been brought about by means of the ray. If irritations of all forms are avoided, it is known that they have remained so for many years.

Several cases were treated under a mistaken diagnosis and afterwards were submitted to an operation before the correct diagnosis was obtained. One, a very noteworthy case, a patient referred to me by Prof. Wm. E. Morgan suffering from neuroma of the brachial plexus. I treated with the ray in order to see what the effect would be, as the results of an operation were not contemplated with much satisfaction, involving as it did the possibility of paralysis of the hand. He was under treatment for three months, and only a slight improvement took place, and the skin became so inflamed that it would not tolerate any more ray. Prof. Morgan then operated, and much to his surprise found it had been a sarcoma, but that it had undergone a fatty degeneration for a distance of one and one-half inches, showing only a small amount of the characteristic tissue left. The operation was done over six years ago and no recurrence has taken place, showing that

the ray has deprived the remaining tissue of its power to reproduce itself.

Surgeons who have removed a sarcoma that has not been rayed, and seen a recurrence take place within a month nearly twice the size of the one removed, can appreciate the immense help the ray can give them in these cases. This result has been duplicated in several cases I have treated, and makes me believe that no sarcoma should be submitted to an operation until they have been rayed from four to six weeks, for the simple reason that the X-ray deprives the sarcoma cell of its power to reproduce itself, and when this result has been brought about if a foreign mass remains the surgeon can easily remove it, and be assured that no recurrence will take place.

Toxin Treatment in Sarcoma—This result may be intensified by the simultaneous use of Coley's toxins in connection with the ray. In some unexplained way these toxins ward off the approaching disease, and in many cases seem to cause its disintegration. I have found however that after a certain time has elapsed that the toxin seems to lose its effect and may possibly contribute in no small way to the cachexia that is prone to develop in the latter stages of sarcoma.

I have been very fortunate in attracting a great number and varieties of sarcoma for treatment, but have had very few cases that even a reasonable hope has been entertained about the possibility of a recovery taking place. The great majority of cases presenting themselves have been post-operative cases, with a recurrence beyond all hope, or cases of inoperable sarcoma with a tumor involving a vital organ, or so large that a cure seemed impossible.

It is among the primary cases that I have had my most striking results, and have come to the conclusion that the X-ray has a specific effect upon sarcoma of the soft tissue. I have not treated a case of hopeless sarcoma where pronounced results have not taken place. The disease has been promptly checked and a retrograde process takes

place that will progress until a certain point is reached; many times until the complete disappearance of the tumor, and occasionally stopping short of complete absorption. A general improvement in health takes place, and the patient is very much encouraged. I have not found that metastases are hastened by the absorption of the tumor as has been alleged. Many of my cases have recovered so fully that it would be impossible to detect the presence of any trouble having been there, and some have been immune from recurrence for several years. Although I do not consider time much of a factor.

Osteo-sarcoma—This form of sarcoma offers considerable difficulty in X-ray treatment, as absorption will not take place to any great degree, and at times the texture of the bone has been destroyed and weakened, so that a small amount of violence may be followed by a fracture. An interesting case of this kind occurred in my practice that of a young man with an osteo-sarcoma of the humerus, which had been rayed for four months, and one day he was thrown off the street car, receiving a fracture of the diseased member. I looked upon it as a helpless and hopeless case, not dreaming that a union could be produced under the conditions named. His arm was set in the usual manner, and much to the surprise of all of us a prompt union took place, and what was of more importance, it did not stimulate the sarcoma to increased growth.

I feel satisfied in my own mind that a sarcoma of this kind may have its growth stopped, and by cautious raying that all of the sarcoma tissue gradually will be replaced by connective tissue or undergo a fatty colloid degeneration.

Operations in Sarcoma—I have observed the amputation of a number of limbs in young people during the last six years; the surgeon taking this desperate step in order to allow the patient to escape with his or her life. Every case has been followed with a fatal recurrence within a very few months. One that I well remember, a beautiful

girl 18 years of age, brought up under the most careful and refined surroundings, who developed an osteo-sarcoma of the tibia. She consulted a surgeon and was advised to have the limb amputated above the knee in order to be clear of the diseased tissue, this was done, but within six weeks of the operation the osteo-sarcoma again put in its appearance. The lower leg was separated by a tourniquet applied so as to prevent any blood from escaping at the operation into the open wound. The wound healed nicely but a recurrence took place in the stump. An immediate operation was done, and the leg amputated at the hip joint. The wound healed kindly but in six weeks it was noticed that she was having increased difficulty in breathing, and it was supposed that an empyema existed, as the left side of the chest was flat. She was brought to the laboratory and a few skiagraphs made of the chest, which confirmed the suspicion that she had a sarcoma of the lung. The course of the disease was very rapid, and she died within four months from the discovery of the trouble. This is only one of a great number that have forced themselves upon my attention since I have been engaged in this work, and only goes to confirm the opinions formed while I was actively engaged in surgical work, that it is a known fact that we cannot either cut out or cut off a sarcoma. The metastases form very early, and all that is required to make them develop is the shock and exhaustion that follows a major surgical operation. Anything that lowers the bodily resistance allows these minute sarcomas to overcome the natural body antagonism and grow.

Post Operative Sarcoma—This is one of the most malignant and rapidly growing sarcomas that we have had any experience with. A general metastases takes place, and the recurring tumor attains a great size in a few weeks, causing great pain and prostration. The X-ray will not be of any permanent value if not used immediately upon the appearance of the tumor, as after a few weeks the enormous number of metastases and the size of them

will develop a degree of prostration not compatible with life. Occasionally a number of cases of recurrence do not grow so rapidly. The body offers an effective resistance, and in cases of this kind the X-ray can be relied upon, and it will rarely disappoint the operator. What has been done in this line by others will well repay investigation.

A case was reported by Chas. H. Fessenden, M.D., Neuton Center, Mass., in Archives of Electrology and Radiology, July, 1904, of a sarcoma on the lobe of the ear of a young lady. She had two operations but a prompt recurrence took place. There was pain, induration and an oozing present when she came for treatment. Five treatments were given with a high tube target at one foot, resulting in disappearance of pain and induration and the scab became dry. She left the city for a year and when she returned reported that all signs had disappeared shortly after she left. Later a slight redness and induration returned which yielded and disappeared after twelve treatments.

E. W. Smith, Jour. Adv. Ther., May, 1904, reports one round cell sarcoma of the cheek, and one round cell sarcoma of the neck. No special details are given, but sarcomas of this kind are usually rapid in their growth.

A large fibro-sarcoma treated by Roentgen radiation, paper read by Clarence E. Skinner, M. D., before the International Congress of Electro-Therapeutics. This patient was a post-operative case, and had been for several months under Dr. W. B. Coley, whose description of the case up to this time can be found on page 767, Vol. XXI. of the 20th Century Practice of Medicine.

The patient has a well-marked family history of malignant disease, and had been operated upon three years before for what was regarded as a fibroid tumor of the uterus. Tubes and ovaries were removed at the same time. Two months previous to her calling she had noticed a hard tumor in the lower part of the abdomen involving the cicatrices. There was no pain or discomfort, but a rapid increase in size until a tumor the size of a cocoanut formed, filling up the lower part of the abdomen and the

iliac fossa, extending nearly to the umbilicus. The tumor was firmly fixed, and seemed to involve the abdominal wall. An incision was made under cocain and a small section taken out for examination which proved to be fibro-sarcoma.

The toxin treatment was used for ten months, with a reduction in size of about one-half; later on the toxins seemed to have lost their effect and the tumor began to grow again, first slowly, then rapidly, so that by January, 1902, she looked like a pregnant woman. The X-ray treatment was begun January 28, 1902, with a high tube. The tube which was used first upon one side of the tumor and then upon the other at each seance. She received forty-six applications up to June the fifth, a period of 125 days. The growth increased in one diameter but decreased in another, so as to make it appear irregular. She had several attacks of prostrations accompanied by febrile movements that lasted for several days, probably toxemic in character. Aside from these attacks her general condition was good, and she was constantly gaining in strength, and could walk well. On June the seventh she was sent away for a ten days' vacation, and a marked change took place during her absence, she had a good color in her face, her step was more elastic and the toxemias had left her and she was enjoying better health than she had for many months. The tumor had decreased in size, and she found it necessary to shorten her waistband and the front of her skirt in order to keep it from trailing upon the ground. Treatment was again resumed and up to September 3, 1902, she had received thirty-one radiations. Her strength increased gradually, and the tumor slowly but steadily decreased in size, and she seriously considered the possibility of resuming her occupation as a school teacher, which had been interrupted for over a year. She once more resumed her work and came for treatment each week, which she received every five days until the following April, from this time to September she received a treatment every fifteen days. When

clothed the tumor was seemingly larger. During September an area of necrosis the size of a dollar developed and treatment was suspended for a time. The treatment was continued at intervals of 37 days until May 20, 1904. The patient's weight increased to 147 pounds and the tumor had entirely disappeared.

It seems very unreasonable to not use this method of treatment instead of uncertain surgical measures, when it can bring about the resolution and disappearance of a tumor this size.

Geo. C. Johnson, M. D., Pittsburg, Penn., reported three cases at the fourteenth annual meeting of the American Electro-Therapeutic Association. All of them were recurrent and very extensive when turned over to him for treatment. One, the father of a physician fifty-six years of age, was taken "as he expressed it," with a cramping of the abdominal muscles, and a large number of globular masses became apparent. He suffered great pain and rapidly became cachetic. Upon examination Dr. Adair found a very extensive growth involving the right rectus muscle and a portion of the left. An operation was decided upon and was performed by Dr. Langfitt, which disclosed such extensive involvement of the peritoneum and omentum so as to preclude the possibility of complete extirpation of the growth. The surgeon removed the right rectus muscle and a portion of the left, and such other portions of the growth as seemed possible, in fact, so much was taken away that it will be necessary to wear an abdominal supporter the rest of his days. After convalescence he was brought to Dr. Johnson with the request that he do as much as possible to inhibit the growth of the remainder of the tumor that was not removed. Treatment was given daily for two months. Great care was exercised to prevent a burn, and the skin was carefully tanned, the pain disappeared, abdominal wall became soft and no evidence of a tumor remained, he gained thirty pounds and his general health was good. He has

been examined by a number of surgeons and no evidence of disease can be found.

Case 2. Miss O., age 42, recurrent sarcoma of the vulva. The patient noticed in 1900 a swelling and tenderness of the pubis following a blow from the corner of the table. The swelling rapidly extended down into the labia majora, the pain became so severe that she was compelled to submit to an examination from her physician. He recognized the trouble and advised its removal which was done by Dr. C. B. King. Six months later the growth returned in the scar, and as the tumor had been proven malignant by the first operation a second one followed immediately which gave relief for several months, when the trouble returned with all of its old symptoms, this time characterized by greater rapidity of growth and extension. The surgeon refused to operate and suggested that she take radio-therapeutic treatment, which was undertaken with considerable hesitation owing to the extent of the growth. Three treatments a week were given until a mild dermatitis was produced, which was followed by a rest until the skin recovered, when treatment was resumed with a higher tube until a severe type of dermatitis appeared. By this time the tumor had completely disappeared and she was in excellent health.

Case 3. Mrs. R., referred by Dr. Mercer with a history of three operations for the removal of a growth involving the entire upper chest, the suprasternal notch and the left triangle of the neck up to the insertion of the sterno-cleido-mastoid muscle. Her voice, owing to the encroachment upon the larynx was not above a whisper, she also suffered with dryness of the throat, and a broad collar of ulcerations studded with shallow craters discharging a foul smelling pus remained around the neck and chest which were unquestionably tender. She suffered agony, and was in a pitiable condition. Daily treatments were given with a low tube and within two weeks the pain was relieved, discharge had lessened and the odor had disappeared. As soon as granulations appeared the

growth on the side of the neck was attacked with a medium tube and a burn of the first degree produced, with the result that the growth broke down under the skin and discharged along the sheaths of the muscles at the opening of the suprasternal notch. The treatment was renewed vigorously and cicatrization took place rapidly and for two years she has been free from any indication of the former trouble, and is enjoying good health.

SARCOMA.

The small number of cases reported cured by strictly X-ray operators, of this disease is remarkable. The reports emanating mainly from people who are making the Roentgen ray a secondary part of their business. In conversation and correspondence with some of the most noted operators, I find that every one of them has a great number of successful cases to record, but they are reluctant to commit themselves for fear of the reception reports of this kind receive from the medical profession. They all realize that a more desirable and successful method of treatment is expected by the profession than the Roentgen ray has proved to be up to date, and are just as firmly convinced that the ray is the most successful treatment we have ever found in this disease. They recognize its limitations better than any other members of the medical profession, and have been fearful of starting an avalanche of cases to their laboratories before the method has been on trial for a number of years.

SARCOMA.

Dr. J. Befat, in the Archives of the Roentgen Ray, October, 1906, speaks of sarcoma in this way, "Certain cutaneous saromas regress with astonishing rapidity under the influence of the X-ray. They appear to be even more sensitive to this action than even epithelioma.

There exists very great difference in sensibility among Sarcomas that have invaded the deeper plains, which cannot be in any way explained by histological consideration.

A factor of importance is the rate of evolution; the slower the growth of Sarcoma, the greater the chance of success. I have seen enormous sarcomatous masses regress rapidly under the treatment properly carried out, not only without the least sign of intoxication, but also with material improvement in general health.

This exquisite sensibility to irritation, permits one to understand the marvelous results obtained by Kienback in the case of an enormous Sarcomatous growth in the mediostinum and by Imhert and Marques in the case of a Sarcoma of the tibia.

Dr. F. Besserie, Archives Roentgen Ray, October, '06, reports two cases of Manning, Melano Sarcoma, treated—both cured, with one recurrence. Diffuse cutaneous Sarcoma, eight cases treated and cured.

Dr. Robert Abbe, Archives Roentgen Ray, October, '06, (Surgeon to St. Luke's Hospital of N. Y.), says, "In Giant Cell Sarcoma, and some round cell Sarcoma, there is a prompt and wonderful retrograde, until tissue like the eyelid or the jaw bone, which has been supplanted and apparently destroyed by the Neoplasm, are restored to former conditions, ossification promptly taking place in the bone Sarcoma which shrinks to its former shape, while in the eyelid a restoration occurs, not only of the normal edges and surfaces of the lid out of the chaos of a hyperplastic tumor, but the function of the lost hair-bulbs is restored, and the eyelashes grow again. Nothing in a surgical experience of thirty years has given such wonder-compelling attention as this retrograde change."

TUBERCULOSIS.

The radio-therapeutic treatment of tubercular infection has been nearly as satisfactory as the treatment of skin diseases, only requiring a longer course of treatment and more attention to detail I have seen cases of local tuberculosis recover in my laboratory so promptly as to seriously question the diagnosis.

The effect upon this disease was discovered accidentally during the earlier experimental work with skiagraphy, my attention being attracted to its apparent value by a clinic patient at the Chicago Post Graduate Medical School. I was endeavoring to make a collection of skiagraphs covering tuberculosis of the lungs, for a paper I was then writing. The apparatus was poor, skill and technic were lacking, and we were not then aware of the possible dangers of the X-ray. This gentleman had l een attending the clinic for some time, and was pronounced as being far advanced in the secondary stage, and no special hope entertained of his recovery taking place I selected him as a suitable victim of my first skiagraph of the lungs. I exposed him daily for about ten days before I succeeded in getting a good plate of his lungs. He informed me that the treatment had done him good and begged me to continue it longer. His request was granted, and I gave him a treatment of 15 minutes three times a week, for several months with steady progress until apparently he made a complete recovery. This case led to farther experimenting with other cases in the clinic and the success was so pronounced that a series of animal experiments were made, in order to see if any real basis existed for our results.

Experimental Tuberculosis—A large number of guinea pigs were inoculated with tuberculosis, some were treated with the ray, and some were not treated. It was found that as a general rule those treated with the ray were slower in showing sickness, that the course of infection was milder, and in many cases a spontaneous recovery would take place. The experiments were varied in many ways, but the results were substantially the same. Cultures were made and some exposed to the ray while others were not, and it was found that the pigs inoculated with the rayed cultures were invariably several days to a week behind the others in showing an increase of temperature, while the course of the disease was much milder, and many of the cases recovered This experimental work apparently

gave us a sound basis for the treatment of this disease, because the ray seemed to be detrimental to the tubercle bacillus itself. In some way the ray seems to deprive the bacillus of its reproductive power, while not entirely destroying its violence, is of sufficient power to lower its vitality so that it can be effectually checked by the natural resisting power of the body. This power of the ray, as well as the demonstrated nutritional value of this treatment has astonished me many times clinically until I believe today we have no other known treatment in medicine that is capable of giving such fine results in local tuberculosis. I have had the privilege and pleasure of using this treatment in one hundred and sixty-three cases of local tuberculosis, exclusive of lupus; and in those cases that I have had under my control for several months I have only good results to report. The character of the cases treated includes nearly every joint in the body, including infection of the spinal column, and it may be said that any case of local tuberculosis in good bodily health will recover under persistent radiation. It is frequently necessary to use other means with this treatment, depending upon conditions that may exist in each case. I have used this treatment in many cases where the patients have consulted some of the most eminent physicians in the world, and have been told frankly that they were incurable, and have had the satisfaction of watching a slow but steady improvement take place until eventually they were cured.

By watching a number of these cases of different nationalities and temperaments yield to this treatment where all other things have failed, is very apt to produce more or less enthusiasm in the operator. The same effect is noted in cases of lung tuberculosis where favorable results may be looked for, but many of these cases do not react favorably to the ray, the bronchial tubes become so dry from the radiations that it is with extreme difficulty that the products of the disease are raised. This effect is noted in a minority of cases, but is extremely distressing

when present. If we could devise a way to eliminate this disagreeable result, we could expect the same success as has been noted in joint affections, but as yet no way has been found to avoid this effect.

As a general proposition a case of tubercular infection shows signs of improvement within two weeks after the

TUBERCULAR ULCERS INOCULATED FROM A DISEASED JOINT

treatment is started, the improvement will be slow but steady if the proper care is taken to give just the right

amount of the ray; if too much is given the secretions dry up, the cough becomes harsh, and the temperature begins to rise, while exhausting night sweats will deprive the patient of his sleep. I have succeeded in controlling this temperature and toxemia by means of a special serum, and have made some progress in immunizing the horse, from which the serum is obtained. It is possible that enforced rest might work well with a certain class of people, but I must confess that it has been detrimental to all of my patients, and I insist upon open air exercise, and where impossible, calisthenics is substituted within doors with open windows, and if the cough is very annoying, and the toxemia very marked, a nebulizer spraying some sedative oil, the air being charged with carefully washed ozone. Opium or its derivatives are not indicated in the treatment of this disease, as an immediate increase of temperature is noted following their use. Stimulating expectorants if they do not interfere with digestion may be used with profit, always remembering that a tubercular cavity freely discharging causes very little toxemia, and as a general rule has little effect upon the bodily health, while a closed cavity may destroy by means of its toxins two pounds of flesh daily.

Optimism in Tuberculosis—Hope is of vital importance to these lung sufferers, and the successful physician is the one who can remove the black cloud of despondency and substitute a cheerful buoyant spirit. A good illustration of this occurred in my practice ten years ago. A young girl struggling, with insufficient nourishment, to become a teacher in our public schools, developed a patch of lupus upon her face, and after the surgeon had removed it, and the dermatologist cauterized it with live steam, she was referred to me very much despondent. The patch had spread rapidly in spite of treatment. Six weeks of radiation together with a positive assurance of success wrought a marvelous change, and a cure was effected. Three months after she was cured a sister died of pulmonary tuberculosis, and six months later the mother

passed away with the same disease. Of necessity the girl was compelled to take care of sister and mother, and eventually became infected herself, apparently with the rapid type of tuberculosis. Her family physician informed her to that effect, she being thoroughly tired out and discouraged did not think it worth while to make a fight, until she was very much reduced in weight, and in a miserable condition. Her troubles became more than she could bear alone, so she called to bid me farewell. By an effort I got all of the history, and satisfied myself by making a skiagraph, that the small cavity she had in her lung was not responsbile for her condition; in other words, while she had tuberculosis she also was nearly scared to death by the apparent hopelessness of her condition. After my examination I told her that with her active co-operation I could make her a well woman in four months. I assured her that while she had a cavity it was of no special importance, and that she would not only live but be able to carry out her life's ambition of becoming a teacher in the public schools. I directed her to resume her studies, prescribed calisthenic exercises, gave her the ray, controlled her diet, selected her outdoor diversions, and was rewarded with a steady improvement that eventually was successful. She is well, has attained her ambition, and is grateful for the mental support she received at a critical time.

No useful purpose is ever served by telling a patient suffering from a chronic disease that it is both incurable and fatal; for nothing is so certain in this world as the effect of the mind upon the vital processes. You convince the average human being that his time has come, and he will rarely disappoint you in fulfilling your predictions. When cool reason leaves its throne and is superseded by a vague unreasoning terror, chaos presides over the vital functions, and death is inevitable. The brutal truth is not always the best for the patient, for the wellspring of life is founded upon hope, and without that greatest of all human virtues, a man is brutalized and be-

comes neither a fit associate for himself or others. Some people are mentally of a negative make up, and can be cured in spite of their determination not to get well, but where one success is obtained you must record your failures by the thousands.

It is my conviction that all cases of tuberculosis, that offer a fair hope should be encouraged to fight; rouse all the sporting blood in their nature, and put it upon a personal basis, impress them that it is a fair fight between themselves and the disease, flatter their vanity from a muscular standpoint, and put them to work to develop their muscular system, arouse their enthusiasm, then give them proper treatment and watch the result. Will you fail? Rarely, if the patient receives the proper mental support. You will say, this is not radio-therapeutic treatment, and rightly; but this therapeutic measure or any other will not give you success. In other words I wish to make it plain that in pulmonary tuberculosis that no agent can do any good without a firm conviction in the patient's mind that it is helping him.

With local and joint tuberculosis the general bodily health is usually not influenced, and as they have no fear of death upon their minds we find the ray supplemented with the proper supports is all sufficient. The radiations should be continued over several months, enough to bronze the skin, but avoiding the irritation of it. It will be found that a slow but steady progress is made, and eventually a cure seems to take place; sometimes we have a stiff joint, and occasionally one with perfect functions. We are able to accomplish in six months with the combined method, results that formerly required two years by immobilization alone. It has passed the experimental stage and I have no hesitation in saying that the results cannot be duplicated by any other known method of treatment.

Tuberculosis of Bone—Where the bone is seriously involved around a joint, it is sometimes desirable to inject the joint with a Bismuth Subnitrate emulsion before treat-

ment. Bismuth acts as a transformer of the ray. The presence of this salt in direct contact with the diseased surface is able to bring about changes impossible with the ray alone. New discoveries along this field may be made in the near future that may change many of our ideas regarding therapeutics. Numerous salts in solution give off lights of different wave lengths, so that we can imitate nearly every wave in the known spectrum.

Fluorescence of Solutions—Many are not poisonous while some cannot be used internally. To render the blood luminous, and send it coursing through the body, reaching each single cell, carrying energy in the form of light to the darkest recesses of the human body, is possible. Its effect upon the body is not known, while the effect upon bacteria is known accurately. It unquestionably will be one of the coming fads in therapeutics, and if measurably successful can only be supplanted by the "antitoxin," the substance that is being sought that will prevent the damage done by the toxins of various bacteria.

The technic for treating deep-seated tuberculosis of bones, joints, etc., consists of the use of a high old tube, well plated with aluminum alternated every third time with a low tube of about one and three- fourth inches resistance. The exposure with the high tube is 15 minutes three times a week, with the low tube not more than ten minutes, using one milliampere of current to actuate the tube which is placed at a distance of 12 inches from the target. The infection is approached from different directions, in order to minimize the danger of irritating the skin. The treatment is kept up for several months, with intervals between, in order to give the maximum treatment possible; it may be given without danger. If the part treated is subjected to a strain in moving about, it is necessary to give it a complete rest by immobilization. Some method should be devised which will allow the patient to go about his business, as it is my experience that complete rest and confinement to the house is fatal to a satisfactory result.

Tuberculosis of Peritoneum—In tuberculosis of the

peritoneum, it is sometimes necessary to tap the abdomen in order to remove the superfluous fluid; but this should never be done until the patient has been under treatment for a few weeks, it being better to expose with the patient lying down, as the water will absorb all of the energy of the ray. The only thing absolutely required if this technic

TUBERCULOSIS OF THE FACIA PLANES OF THE RIGHT LEG OF 10 YEARS' STANDING. PATIENT HAD BEEN A CHRONIC INVALID. REFERRED TO ME BY DR. SHEPPARD BARNUM OF LOS ANGELES, CALIF.

is used is patience and faith. You must remember that all of these patients have been told that they are incurable, and naturally are very despondent. They have very little patience with experimental work, but will grasp at the straw offered them when assurance is given that a cure is possible, and very probable, a matter of time from four to six months is of little consequence to them, compared to either death or chronic invalidism.

In many instances I have been obliged to furnish the backbone for an operator who has become discouraged because of apparent lack of success. I am glad to say that persistence upon their part won the day. If the lesion is small a quick effect will be had, while if extensive destruction has taken place, the time must of necessity be longer.

SAME CASE AFTER ONE YEAR'S TREATMENT. NOW WALKS WITHOUT CRUTCH OR CANE

Tubercular lesions heal slowly as a general rule, but they are by no means as hopeless as the profession seems to regard them, and if hope and ambition are kindled in their hearts wonders can be accomplished.

I would urge all X-ray workers to try this treatment in all cases of local tuberculosis, use it persistently and I believe you will be astonished at the results obtained. I have been and have many patients grateful for my optimism.

Dr. Emil Gribbe reports as follows in the Scientific American Supplement, October 6, '06:

Tubercular gland cases under treatment, 14; primary, 10; secondary, 4. Average length of time under treatment, three months. Results: symptomatic cures in 7 primary cases and in 3 secondary cases; died while under treatment, 1; stopped treatment for some cause or other, 3.

Lupus cases treated, 35; primary, 20; secondary (recurrent), 15. Results: symptomatic cures in 28; died from intercurrent disease while under treatment, 2; stopped treatment before discharged 5. Average length of time under treatment, two months. The term "symptomatic" cures is used to denote cures which have not yet passed the three-year surgical limit. Of the above cases, the disease was located on the trunk in 8, on the head in 15, and on the extremities in 12.

TUBERCULOSIS OF WRIST JOINT CURED BY X-RAY

Dr. Emil Grubbe, Alkaliodal Clinic, 1904, reports 54 cases of Pulmonary Tuberculosis, treated with the X-ray, and reports 20 cases symtomatically cured, 16 improved and six died while taking treatment.

He continues as follows: "I am frank to say I do not consider the X-ray a specific in Pulmonary Tuberculosis, but in view of the fact of the large mortality rate from this

disease, any treatment which can even mildly cope with it, should be assigned a conspicuous position among its remedies."

By selecting proper cases, it will always succeed in alleviating, and in a large percentage of cases it will effect a cure. I believe the X-ray should be accorded most respectful consideration by all who have charge of tubercular cases.

In conclusion it may be stated that under X-ray treatment:

1. Tubercle bacilli are destroyed.

2. Hemorrhages, pain, night sweats, and fever are controlled.

3. Expectoration is easier and more copious.

4. The existence of cavities and hemorrhage does not preclude recovery.

5. All stages of pulmonary tuberculosis are amenable to this treatment. As with all other therapeutic measures, the earlier the application the more favorable the prognosis.

6. Local conditions alone should not determine the prognosis. The patient's general health is a very important factor and should always be carefully considered.

7. Appetite, weight and strength increase rapidly when the case is a favorable one.

8. In addition to its local effect a general stimulant effect is noted.

9. Specific curative effects should not be expected in all cases.

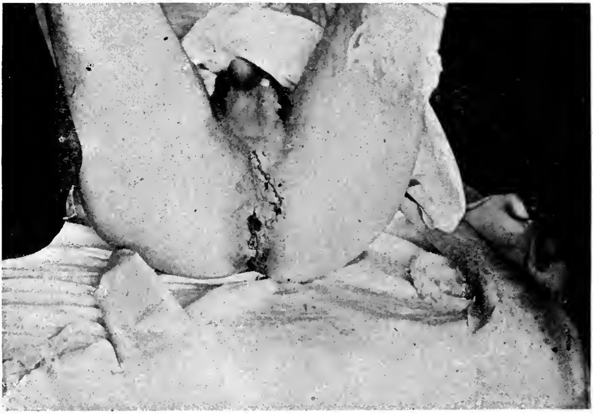
TUBERCULAR FISTULA.

Many novel methods have been tried with this trouble, to not only make a correct diagnosis of the actual area involved, in order to try to remove it by surgical means, but to leave something within the tract that would excite granulations.

A successful method of diagnosing the exact outlines of the fistula has been solved by many operators, by injecting an emulsion of Bismuth Subnitrate in Almond

Butter, stiffened with white wax. This shows the exact outlines of the cavity by means of the X-ray, with all of its fine ramifications, so as to guide the surgeon to a successful operation.

That there was any curative properties to the procedure was not suspected until Dr. Emil G. Beck inadvertently left an emulsion within the cavity for a few weeks before operation. He discovered that the emulsion had not only been absorbed, but further that the disease was cured. He carried out the procedure upon several



TUBERCULAR FISTULAE CURED BY THE X-RAY ALONE

chronic cases, and demonstrated that it was an unqualified success, only one patient dying from the disease before a successful result could be obtained. He repeats the injection at intervals as it is absorbed, making a skiagraph after each injection in order to keep an exact record of the progress made from time to time.

He used the procedure upon Psoas and Hipjoint abscesses. A new era has opened for this much-abused class of people. To my knowledge, I have known many of these cases to have had from 10 to 15 operations, trying to regain their health.

Opinions differ as to the true remedial action of this procedure, doubt being expressed as to whether it is the radio-activity of the Bismuth or the obliteration of the cavity by a substance that can supply a framework for the granulation tissue.

Dr. Beck gives the following formulae for the paste, for diagnosis and early treatment:

℞	Bismuth Sub. Nit.	30.
	Vaselin	60.
	Mix while boiling.	

TUBERCULAR SINUSES WITH EXTENSIVE INFILTRATION. CURED IN FIVE MONTHS WITH X-RAY

For late treatment:

℞	Bismuth Sub. Nit.	30.
	White wax	5.
	Soft paraffin	5.
	Vaselin, mix while hot	60.

Technique—The fistulae should first be dried out with gauze, a narrow strip being crowded within the cavity and removed just before the injection. The mixture is sterilized and injected with a Valentine injecting tip on a glass syringe. The emulsion is injected rather warm, and

an ice bag applied to cool the paste, so it will not escape when the finger is removed from the opening.

This procedure is repeated at intervals as may be indicated, and a slow but steady improvement is noticed, until eventually a cure is obtained.

A physician should always make a study of the flora in each discharge, in order to take advantage of some of our numerous serums or in order to try the vaccination method. Too much reliance must not be placed upon the X-ray alone, we should always remember that we are practising medicine in the interest of the patient, and not to prove or disprove anyone's work, and to avoid using known means or approved means to bring about this result is culpable and should subject the physician to censure. Much of my good results have been due to my availing myself of all known means of relief, and unquestionably would have been bad, if dependence had been placed upon the X-ray alone.

TUBERCULOSIS OF LEG. FOUR YEARS STANDING. CURED IN FOUR MONTHS BY X-RAY

LEUCOCYTHEMIA.

This is an exceedingly fatal disease in which medicine has been of no avail, and runs a very rapid course. The white blood corpuscles are enormously increased and a peculiar anemia is present that suggests the grave condition of the patient. The cause of this disease is not known, we have only theories to account for the condition.

Physicians can imagine the astonishment in our laboratories when we found that the X-ray had a profound effect upon this disease, and that an enormous spleen would disappear in a few weeks under this mysterious force; astonishment followed by regret in the earlier cases

owing to the prompt return of the tumor and a delayed fatal termination of the case. Immediately a series of experiments was commenced in order to improve the technic and prevent the usual recurrence. A closer study was made of both the physiological and pathological facts that could be gained from animal experiments, and the post mortem table, from which we learned that it demanded an X-radiation over the entire body, and moreover that the radiations must be of a powerful type with short shifting exposures so that every part of the body would be well rayed at least once a week. Since adopting this technic I have had two mild cases that are now alive and well five years after treatment was stopped.

TUBERCULAR INFECTION OF FASCIA PLANES, BEFORE TREATMENT.

The effect of the ray in this disease should put at rest the absurd statements made from time to time by "clinic" operators, that no effect of the ray can be had below the surface. If operators do not get an effect from the ray beneath the skin they are at fault and not the ray, as it is perfectly possible to produce an internal burn without affecting the skin in the slightest degree. This can be accomplished by regulating the electro-motive force of the ap-

paratus so that the desired degree of penetration is present, and then increasing the distance of the tube from the skin, using a greater amount of current to compensate for the loss of energy at the desired point, caused by the distance from the tube. Many operators seem to think that no change in technic is necessary and invariably treat a skin lesion and a deep-seated cancer with the same tube, being guided only by skin toleration. As I have pointed out many times before, it is not the ray that passes through a diseased area that does the work, but it is the ray that is absorbed by the tissue that modifies the physiological processes. The ray must come at rest within the tissues where we can expect results, and this can be calculated to a nicety by proper attention to the apparatus.

TUBERCULAR INFECTION OF FASCIA PLANES OF ARM. THE ARM WAS PERFECTLY CURED BY THE X-RAY AND IS USEFUL.

It is intensely interesting to watch the effect of the ray upon a bad case of leucocythemia presenting itself with a spleen filling the entire abdomen, with the leucocytes enormously increased and an extreme feebleness, and with much distress in the abdomen; the application of the ray soon brings relief of pain and a steady diminution in the size of the spleen, while the white blood corpuscles gradually decrease in number. If when the spleen is reduced one-half the treatment is discontinued things will remain at a standstill for a few days, when an increase of both the

spleen and leucocytes begins again. As soon as the treatment is resumed the growth is checked and the absorption of the spleen continues. When it has reached its normal proportion it is necessary to give supra-renal extract three times a day in order to insure some permanent benefit. Good results have not followed the use of iron or arsenic in my hands, but I have seemed to get good resu'ts from small doses of chloral hydrate The first five cases of this disease had recurrence and died, two of them relapsed three times, and the two that I have mentioned before have apparently made a complete recovery and show no disturbances of the blood-making organs. While thousands of these exist, and physicians admit they cannot do anything for them, I have been able to get only seven cases in as many years, and for this reason have not been able to ascertain if the improved technic, or favorable conditions gave me my success in the last two cases. The effect of the ray is so remarkable in this disease that all X-ray operators should use it by all means, as success has been obtained by other operators in different parts of the world and unquestionably the treatment will show better results with farther study.

TUBERCULOSIS OF THE STUMP. CURED BY THIRTY TREATMENTS WITH X-RAY

ELEPHANTIASIS.

This disease has been found to be very susceptible to radiation, and a few months is sufficient to reduce the parts to normal proportions. Improvement is noted in about ten days and continues steadily until a complete

cure has taken place. No tendency to recurrence has been noted. Large doses of sodium cacodylate are to be given with the ray.

The technic involves the use of a low tube of one inch penetration, moved daily over the infected area for about sixteen days, followed by the use of a highly penetrating ray to promote absorption.

LEPROSY.

It was hardly expected that the X-ray would be of any service in this terrible disease, and when the first few cases were treated the diagnosis was doubted so strongly that it was not deemed good policy to report them, and they were supposed to be tuberculosis, which at times resembles leprosy so closely that experts are often in doubt of its true character. The first case that appeared in my clinic at the Post Graduate Medical School, January 6, 1902, was a Chinaman with the ulcerous type upon the face. Considerable time was spent in confirming the diagnosis, and as soon as it was ascertained that the diagnosis was correct he was treated at the close of the clinic by special appointment, and to the surprise of all of us a rapid recovery took place, and in a few months he was well. It seemed too good to be true and we questioned our own success. The case was watched for several months subsequently with no recurrence. By strenuous endeavor I succeeded in finding one other case in which the American physician diagnosed tuberculosis while the Chinese insisted it was leprosy. This case responded as well as the first to the X-radiations; but I have been unable to persuade any more to come for treatment, though there are quite a number in Chinatown. This work has been carried out lately on a larger scale in the government laboratories in Manila where the disease is very common. If in this disease the X-ray shall have been found a specific it will only go to confirm the opinion of old operators that it is in the most hopeless and seemingly fatal diseases that

the ray is useful, having little or no effect upon ordinary diseases that are susceptible to drug medication.

BRIGHT'S DISEASE.

There is much experimental evidence that in the X-ray we shall find a very useful method of treatment; numerous cases of the disappearance of albumin and casts are reported by different operators where the patient was submitted to X-radiations for some other trouble. As far as I know, no case of Bright's disease has ever been treated by the ray, probably owing to the fact that cases of this kind rarely find the X-ray laboratories, but two of my cases go to confirm my judgment that it is useful. A gentleman who had a bad infection of sycosis around the waist, evidently contracted from a waist band in a bath-house, came to me for treatment and at the same time was suffering from an aggravated form of Bright's disease for which he had been taking the baths in order to obtain relief. He was submitted to the X-ray for several weeks, until the sycosis was cured and I was surprised to learn of the total disappearance of both albumin and casts; he was much improved in health, and went west three months afterwards and I lost trace of him. The second case was psoriasis complicated with Bright's disease; he was under treatment for several months with the disappearance of the psoriasis, albumin and casts, no recurrence noted after six months when he also passed from my observation. Numerous other operators have noted the same phenomena and it may be that in the X-ray we have a desirable method of reaching this condition satisfactorily. Any operator who has a case will confer a favor upon the profession by submitting it to treatment and reporting the results.

HYPERTROPHIC PROSTATE.

It has been proven that the ray has an effect upon all hypertrophied tissue causing a retrograde tissue metamorphosis or atrophy of glandular tissue. Many cases have been reported of its successful use in this disease, and in

my own practice I have seen two cases that have been markedly relieved while treating a tubercular fistula of the perineum, also a remarkable result was obtained in a fibroid tumor while the case was under treatment for tubercular peritonitis. A large myoma of the uterus had shrunk about one-half in size while the patient was undergoing radiations. Other operators have reported the same results and unquestionably it does have a selective action upon fibroid tissue, and would repay farther study along this line.

LYMPHOMA.

The X-ray is possibly the most satisfactory treatment we have today for this condition. A lymph tumor will disappear rapidly under continued radiations and numerous cases have made a complete recovery under this treatment, and no reason exists why it should not become an established therapeutic measure.

TIC DOULOROUX.

The analgesic effect of short powerful exposures as used in skiagraphic work has given relief of several months duration. No good is accomplished by prolonged treatment, but an exposure from a powerful machine capable of making a hip joint exposure in ten seconds at the full capacity of the apparatus will many times give relief lasting several months at a time. I have noticed this same analgesic effect while trying to locate stone in the kidney in large people where it is necessary to make more than one exposure at the extreme limit of the apparatus. One case in particular will explain the conditions that were present.

A physician who weighed 325 pounds was afflicted with a pain in the right side, of so severe a type that opium was necessary to enable him to keep about. The analysis indicated stone and he was referred to one of our local surgeons for an operation. The result of an operation in a man of this type was not contemplated with satisfaction and he was referred to me for a skiagraph. Three expos-

ures were made, and the last one indicated a stone the size of a pea in the kidney; he was free from pain within one hour of the exposure and has remained so for two years.

CARCINOMA.

It cannot be said that the technic has been as well worked out with this form of malignant disease as with sarcoma. There is always an element of uncertainty present in each case treated, and many times the technic has to be changed several times before a favorable result will be produced. "Selective filters" made from membranes and different metals, have not seemed to give as brilliant results as we get in other diseases from their use; occasionally good results, in fact remarkable results, have been obtained in this disease, by first passing the ray through a grounded barium-platinum-cyanide screen, before it is allowed to come in contact with the tumor. Equally brilliant results have followed the use of certain sensitizing agents as bi-sulphate of quinine, flourescine, sodium salicylate, and in fact several hundred chemicals respond to the radiation as a transformer, each giving out a different spectrum. This class of drugs is administered in sufficient dose to make up a required volume in the blood, and when the patient is within the radio-active field, the blood fluoresces with a brilliant light, as it passes through the active field. Many of these substances are phosphorescent as well as fluorescent, and the energy of light is conveyed to the remotest parts of the body. The latent possibilities of this method, when the "right" substance has been found, almost passes belief. If we can find a substance that will give off a dazzling light, approaching the natural solar spectrum, and one that is not poisonous, that we can render radio-active within the blood stream, the question of most bacterial infections will be definitely settled for all time, as there are few bacteria that can survive the solar spectrum for any length of time. Operators who are situated in small places, where experiments upon animals are possible, should carefully consider the possibilities of dis-

covery along this line. The physical field is such a broad one that it is doubtful if it will be thoroughly explored in the next thousand years. As an indication of the possibilities along this line take the Welsbach incandescent gas mantle. Here we have a combination of two rare metals, doing what neither can do alone, and moreover, that they can do it only when mixed in exact proportion, Thorium 99 percent with Cerium 1 percent. This combination giving a light under the energy of heat that resembles the solar spectrum, moreover, it seems to be a constant affair lasting for years without deterioration. It is true the mantle as constructed, may be covered with carbon after use, but the active ingredient may be recovered and used separately. This shows the possibilities of accidental association.

Technic in Carcinoma—The technic that I have used in the treatment of carcinoma, has been to calculate the penetration so that the ray comes at rest within the tissue, as work is done only when the ray is arrested in its passage through space, as the human body, may act as both a transformer and a transmitter, depending upon the velocity of the wave and the definite resistance offered by the tissue traversed. This may be better understood by analogy. If we take a beam of light, and by passing it through a convex lens, we gather all the pencils of rays together and bring them to a fine point. If we will place a thermometer or inflammable material at the apex of the focus, we will appreciate the fact that work is being done, as the thermometer begins to raise rapidly, and eventually a flame will start in our material. All this shows that work is being done at the focus of the lens. If we have carefully measured the temperature of the lens, we will find that it has not increased perceptibly, in other words, it has acted as a transmitter, it has carried the energy but has not absorbed a great amount of it. If we now cover the lens with lampblack, we will find that the energy is no longer transmitted but is absorbed,

and that its temperature is rapidly raised. This point is a very important one in X-ray treatment.

We cannot expect to treat diseases of the skin with a ray that will go through a brick wall. This fact was borne in upon me in the earlier day, when we just began to use the X-ray therapeutically.

Penetration in Lupus—A case of lupus presented itself at the hospital that had followed a severe burn on the chest and back of a young man, who tried the "peeping Tom" act on a fine looking girl. The old lady caught him with a pail of scalding water over the shoulders. A severe burn resulted over the chest and back which became infected with lupus. He presented a disgusting sight when he appeared in the clinic. He had been treated by all known methods without results, and I was constrained to try the ray upon him, and directed it through the chest, as that side presented the worse condition. He was under treatment for six weeks, and apparently no results were obtained. We had about made up our minds that the treatment would have no effect upon the disease, when he said that his back had not bothered him any since he had been under treatment; upon investigation it was seen that the back had nearly healed up. This gave rise to considerable debate as to the cause of this condition and the general idea was that it had been a case of "spontaneous cure." We came near accepting this idea, when a medical wag suggested that we turn the patient around and send the X-ray through the back, and see if we get a spontaneous cure on the chest. This advice was adopted, and we were very much astonished and gratified to see a steady, but sure, healing take place, until eventually a cure was produced.

This curious analogy gave several interesting evenings' debates before the Chicago Electro - Medical Society, and considerable experimenting was done by the different members, in order to ascertain why it was apparently necessary to pass a ray through a human body before it had any medical effect, and eventually it was

found that the penetration of the X-ray must be carefully calculated, so that the ray would come at rest within the tissue, where we desired the work to be done. In the case mentioned the resistance of the body was just great enough to allow the energy to do work, after it had passed clear through. Operators who would be successful with this method of treatment, must mix brains with their work and not absorb the manufacturer's claim that any tube that gives off a greenish-yellow color is suitable for treatment purposes. The penetration, distance and volume, surrounding conditions, must all be allowed for, if results are expected.

Luck as a Factor—It is true that occasionally an operator by a happy combination of tube, apparatus and "fool luck" accomplishes results that make older men marvel. One operator of this kind, whom I started with his apparatus and adjusted for him, had such "luck." He never disturbed the first adjustment for six months, and his success was phenomenal, case after case was brought to me by him for advice and consultation, and as strange as it may seem, he got results in carcinoma that I did not believe possible. In fact, it did seem that about everything he tried the ray upon got well. He became very enthusiastic and eventually the happy combination was broken by some mischance, or his "luck" had left him, as he soon found that he could not duplicate any of his results. The X-ray didn't seem to have any effect upon any disease, and I was appealed to again to come up and see what was the matter. Investigation revealed a "blue tube," giving off no ray, and of course without any therapeutic value. I fixed things for him again, and he had another period of extraordinary success, until the last year, his "luck" has deserted him, and I am afraid he will have to work now, before he is again successful. Radio-therapeutic treatment is full of surprises of this kind, and it has been my fortune to see several people, knowing absolutely nothing regarding the ray, taking risks no sane man should take, yet having the most ex-

traordinary success for a time. They flash up like a "sky rocket," but always land like a "stick."

Success of this kind is exceptional, as most operators are successful only after the most painstaking work upon their part, but while they do not as a general rule, have runs of such phenomenal success, they have individually developed a technic that can be depended upon to produce good results.

This technic must necessarily differ with each size and type of apparatus, and no fixed rules, except safe ones, can be made, if all the conditions are not known in each case.

Of all things necessary in the practice of radio-therapy, is faith. No physician can expect for a moment to get good results with either this or any other treatment, without he himself believes firmly in it, and can impress this belief upon his patients. Certain elements in the medical profession sneer at this statement, and call it faith cure. It would be far better for the medical profession if they had not departed so far from the Gods of their fathers, which made them a charm and comfort to their patients, to go after the strange gods of the Vienna school, who deny all medical value of drugs, and base all medical knowledge upon pathology. It is "scientific" to maintain that drugs are without value therapeutically and a cheerful pessimism may be seen in all medical circles, either as Journals, Societies, or as individuals.

Therapeutic articles have disappeared from our journals, are not discussed within our societies, and as individuals we expend our wisdom in making a diagnosis of our patient's case and prescribe some "ethical proprietary remedies," the composition of which we are absolutely ignorant, at the same time loudly condemning "quacks" and "patent medicines." If a patient falls in our hands, we are looking for symptoms of appendicitis, gall stones, or some other "surgical fad," and it never occurs to us that any medical relief could be of service, we hustle the patient off to a hospital and an operation

is done before he recovers from his bewilderment. This is good practice. The vigilant physician gets the privilege of basking in the sunshine of some great man for a few weeks, while the patient is recovering. The great man gets all of the money, the "Vigilant Doctor" a cordial smile. All progress in medicine must stop, if in the near future a division in duties between the surgeon and physician are not defined, as we have few physicians at present, but the profession has resolved itself into surgeons, assistant surgeons, and would-be surgeons; chaos reigns in therapeutics, the majority of physicians having lost all confidence in the pharmacopia, and are showing a disposition to temporize by allowing a case to drift along, and see if an opportunity for an operation presents itself.

In typhoid fever, where so much of value can be done for the patient, by proper diet and hygienic measures, they are now allowed to drift with little attention or encouragement, but the attention of the whole family is called to the possibiilty of hemorrhage, and all precautions are taken to insure the "operation" at the proper time. It is getting unfashionable for people to die except through the hospital. This condition is unhealthy, is of foreign growth and responsible for the deplorable condition the profession finds itself in large cities.

It is about as impossible to make the profession accept a new therapeutic idea, without the "Made in Germany" label, as to get the "joke" in the proverbial Scotchman's head. But any patented synthetic that is sent to our shores, is seized with avidity, testimonials written, and a great fuss made about it, until eventually it too is killed by the withering pessimism from which the profession is suffering. Unprejudiced observers fail to notice much change in the percentage of death rate, but have noticed an increase in "shock," "peritonitis," "embolism," exhaustion, etc., and the certificate is signed by the clinical assistant or interne in some hospital. Why is it that people cannot be allowed to die in

peace? Why is it necessary to use the forlorn hope? Why should we try and disturb the patients' trust and faith in their medical attendant—even if we think there is no hope for them? No physician is in a better position to observe this pernicious influence than the X-ray operator. The patients' homes, hotels, and boarding houses are invaded by this medical pessimist. They are assured that the X-ray never has or never will cure disease. If you take the trouble to give him convincing evidence among cases very much alive and grateful, you are met with a superior smile, a wise nod and the axiom that cases recover spontaneously you know, or did you have a microscopical examination made and was it confirmed? What argument can be made to an animal of this kind? The only answer is the increasing number of faith healers, Dowieites, etc. The profession has descended from an angel of mercy to a harbinger of evil, their visits are no longer looked forward to with unalloyed pleasure by the patient, but a sense of dread for fear of the decision that "the doctor has ordered him to the hospital." Men of this stamp have no success with radio-therapy. If they cannot give their patients confidence enough to withstand the withering pessimism of chance medical men, they cannot keep their patients long enough to do any real good to them. If you don't believe firmly in your remedy or method of treatment you surely don't think you would be smart enough to fool the average man and woman of the day into thinking that everything was all right. It is a common experience for some patient to show up with a lesion perfectly amenable to radio-therapy, and announce that they had taken the X-ray treatment for several months without benefit, and after persuading them that the X-ray was just what they needed, and that they would surely recover under it, I have found these cases would yield as well and as quickly as cases not treated. Why? Simply because I had given them mental rest, which they never before experienced. Please stop and realize for a minute what it means to an active father or mother, with their

work unfinished, many depending upon them, to be told by an honest and well meaning physician that they are suffering from an incurable disease, and that no hope of a cure or relief exists. It places a human being in the most unfavorable condition to obtain a successful result, and it is my opinion that many patients are simply scared into an early grave. The modern scientific method of diagnosis goes farther to terrorize patients and magnify the importance of their illness.

After a patient has had his blood, urine, feces, stomach, etc., examined and been thumped all over and observed sundry shrugs and wise nods of the head, if he is a nervous man, he is ready for the hospital, by the time the examination is completed, usually in about three weeks. I have been a good patron of the pathological laboratories, for several years, and I am in doubt today of any real value I have ever received from my investment. I have never been in doubt in a single case where the laboratory succeeded in clearing it away. For this reason it seems that the modern training to rely upon outside help for diagnosis is not always in the interest of the patient and physician. A cheerful optimism works wonders in connection with the X-ray, and without it, an operator will rarely attain much success; as it must be known that no case comes to our laboratories that has not been a sufferer for years or comes without a diagnosis of an incurable disease.

Up to eight years ago, we treated no cases that were not pronounced both inoperable and incurable, except the flood of post-operative recurrences from our operating rooms. Every one thought that it was very unlikely that any peculiar medicinal value would be found in the ray, and for that reason operators refused point blank to treat an operable case of carcinoma, but were induced to treat the others because of the well known analgesic effect of the ray, which enabled us to offer these poor storm tossed sufferers almost complete immunity from pain without at the same time depriving them of their senses. A short experience

with these cases began to show a marked improvement, both general and local, and while the majority succumbed to their disease many continued to improve until a "cure" can be said to have taken place. These cases attracted the notice of the general practitioners, and they began to refer more favorable cases for treatment, those of early recurrence after operation. At the same time a general discussion of technic was carried on in the journals devoted to this branch of the art, and as the general truth underlying this kind of treatment was understood our success became more marked, bringing with it a slow, but steady confidence in the efficiency of this treatment among the physicians, and they began to bring in cases that were more favorable in their prognosis. Cases principally who absolutely refused operation, and then for the first time we were able to give the treatment of cancer a fair trial, under as favorable surroundings as may be found in the average operating room.

Case Reports on Carcinoma—A series of 18 cases now over seven years old furnish the basis of my estimate. I realize that it is too few to prove anything, but the success I have obtained is sufficient to encourage others to further study of the subject, and it certainly should seriously be considered as a promising method of treatment. I have shifted from an extreme skeptic to a firm believer, that it is the best means to handle malignant disease that we have today. It is occasionally necessary to supplement the ray with surgical measures, in order to remove a mass too large to absorb, and the surgeon can rest assured that an operation upon rayed tissue will not be followed by recurrence.

Effect of Ray—The results of the treatment by the ray may be summed up as follows: There is first, relief of pain; second, of hemorrhage, or discharge; third, a gradual atrophy of the glands; fourth, an active congestion of the tumor takes place, and fifth, an evident absorption is observed, the tumor gradually decreasing in size, until in a few cases a complete disappearance has taken

place. In the majority of cases, however, we find that a certain amount of the tumor will remain, and may be removed or let alone, as may be thought best by the attending physician, as either method seems to offer equally good results, as the tumors have shown no tendency to grow in the eighteen cases that have been under my observation for over seven years. In six cases where the tumor was subsequently removed to help the patients' peace of mind the characteristic tissue had disappeared.

Anesthetics Dangerous—I would like to say right here that a warning should be sent out to surgeons in regard to patients that have been submitted to prolonged radiations, as it is a known fact that they do not stand an anesthetic well, and several accidents have occurred, due to some change that takes place in the blood cells which makes them respond unfavorably. Ether is the only one of these agents that gives any assurance of safety.

A careful study of my cases will go far to confirm the value of the X-ray in cases of primary cancer which have not been submitted to an operation. Of the numerous cases of post operative cancer that I have treated, putting them all in one class, I have to record only about 22 percent of successes; but I am convinced that it will prolong life for months or years in certain cases if used persistently, except in very old people in whom the operation seems to be the beginning of the end, they have so little recuperating power that they never recover from the effects of anesthetic.

I am not prepared to offer the ray as a cure for cancer; but I am becoming more convinced all the time that it is the most successful, and if persistently given with due regard to the ability of the body to absorb it, good results may be looked for in primary cases.

Dr. Emil Grubbe in the scientific supplement, October 6, 1906, has an extensive article upon the use of fluorescent salts in connection with the X-ray in the treatment of cancer. There are few operators who have worked so

industriously to solve the many problems connected with the treatment of cancer. He says:

"Strontium salicylate when chemically pure occurs in the form of fine white crystals, which are very soluble in water. The salt or a solution of the salt was found one of the most active fluorescing chemicals which we have examined. Although not very much used or mentioned in textbooks as a therapeutic agent, this substance has very valuable properties, chief of which may be mentioned its sedative and anti-pruritic effects when used as a dressing on inflamed or ulcerated wounds. In addition it has a decided tonic action upon the whole system, but more especially upon the blood. It is also antiseptic and antipyretic. After the crystals or a solution of the same have been placed in contact with diseased tissue, the X-ray simply excites the chemical to action, and all the interchange of chemical properties which result from this excitation is appropriated by the cells composing the tissue. It is as efficient internally as externally. It can be applied to the most delicate tissues, as it is perfectly harmless and non-irritating. This substance is particularly rich in ultra-violet rays, and no doubt much of its therapeutic value is due to the fact that we can generate these rays within the tissues, thus getting intimately at the seat of the disease. The salt fluoresces irrespective of the vacuum of the tube used, that is, a low, medium, or high tube will excite it. However, since the X-rays, like all remedies which are potent for good, also possess dangerous properties, we suggest that the technique cannot be too exact or too scientific. Our rule is to use a vacuum just high enough to penetrate the diseased tissue, but no more.

Of the two methods by which strontium salicylate can be introduced into the system and then made fluorescent by X-rays, its use by local external application of the crystals is the simplest and safest method. The subcutaneous method, on the other hand, is undoubtedly the most effective method, but not so simple or safe. Various

factors decide our choice between external application and hypodermic injection. The latter is to be employed in serious cases, and where it is necessary to act quickly and energetically, and in all cases where the disease is beneath the surface and in internal affections. For the treatment of external or ulcerated conditions it is not necessary to inject the salt in solution. The fine crystals of the same may be freely dusted into the ulcer. When used hypodermically, a saturated solution of strontium salicylate in normal salt solution is prepared. The latter solution, which is also fluorescent under the X-ray, will take up about 26 grains of the chemical per ounce without precipitation. This fluid is heated to a temperature of 100 degrees Fahr., just before using. We prefer to inject all around a growth if possible. The needle is introduced at the edge of the tumor, 5 to 10 drops of the fluid injected, then withdrawn, another place selected, and again 5 to 10 drops deposited and so on until the growth has been well encircled. In ordinary cases the injections are repeated every other day, while in cases demanding heroic treatment the injections may be resorted to daily, but always just before exposure to the X-ray. Clinical observation teaches that the dose is not of great importance. However, because the substance is practically non-poisonous, we suggest using as large a quantity at one time as can properly be applied. Personally, we have given 60-grain doses frequently without untoward effect. There have been but few cases in which we found any disturbance whatever, and since overstimulation is the only thing to guard against, the quantity which may be used in a given case depends upon the area of tissue to be treated. Patients do not suffer any inconvenience from the treatment. There is no pain except that due to the introduction of the needle, which is very slight.

Concerning the length of time during which this treatment can be administererd, we will say that it can be used indefinitely. We have one patient who has taken it for

over six months consecutively, without the appearance of any disagreeable symptom or sequelae.

All cases receive the X-ray treatment daily from the beginning; sittings last 8 to 12 minutes, until dermatitis comes on, when we stop. We have employed this method in over one hundred cases, and although individual conditions have varied considerably and many forms of tissue have been under treatment, we have found few contraindications to its use.

An explanation of the possible action which takes place in the tissues under this treatment can only be theoretical. Therefore, we do not care to go into detail concerning this phase of the subject. In all probability its action is largely analogous to that of X-rays. The fluorescence in the tissues probably has a treble action. First, due to the fact that the rays given off are ultra-violet, they are bactericidal, or at least have the power of inhibiting bacterial growth; second, the irritating influence is such that nutrition is excited and stimulated; and third, granulations are excited, and thereby rapid healing ensues. There is of course also the probability of the production of new chemical compounds in the tissues as fluorescence is developed. And we may even say that active chemical decomposition takes place, and the effects of the nascent chemicals are made use of by the tissues in which they are liberated.

Of considerable importance is the fact that this chemical exerts not only a local action, but also a general stimulating and tonic action. In many cases it is of great advantage if we can use a remedy which will affect the general as well as the local conditions of the patient.

We must never forget that success of any treatment for a malignant condition does not necessarily depend upon the treatment per se, but to a very great extent upon the physical condition of the patient and also upon the particular part of the body affected by the disease."

He reports cases in the same article as follows:

In the majority of cases herein mentioned, pathological examinations of the growths were made by competent individuals previous to our application of this treatment. The diagnoses therefore were made with all the aids of modern medical science.

Epithelioma cases treated, 27; primary, 18; secondary, 9. Results: symptomatic cures in 18; died from intercurrent disease having no apparent connection with the epithelioma, 1; died from general infection, 3; stopped treatment before being discharged, 5. Average length of time under treatment, two months. The disease was located on the trunk in 3, uterus 2, head 12, and extremities, 10.

Carcinoma of breast: cases treated, 12; primary, 3; secondary, 9. Average length of time under treatment: primary cases one month, secondary cases three months. Results: symptomatic cures in all primary cases and in five of the secondary cases; died from general carcinosis while under treatment, 1; stopped treatment before discharged, 3.

Carcinoma of the rectum: cases under treatment, 3; primary 1; secondary, 2. Average length of time under treatment, five months. Results: symptomatic cures in 1 secondary case and none in the primary case; died from general carcinosis,1.

Carcinoma of the uterus; cases under treatment, 8; primary, 2; secondary, 6. Average length of time under treatment, four months. Results: symptomatic cures in 1 primary case and 3 secondary cases; died from general infection, 2; died from concomitant disease, 1; stopped treatment for some other treatment, 1.

PAGET'S DISEASE.

This disease was discovered in 1874 by Sir James Paget, it being a disease of the nipple, the areola, and the surrounding tissue. It usually occurs in females over 40 years of age.

Symptoms—It commences as a fissure or abrasion and is accompanied by a redness of the skin and pruritus. It gradually spreads over the nipple, and the surrounding skin, and is characterized as a bright, red patch, giving the appearance as if the skin was varnished. Clear yellow sticky fluid exudes abundantly from the surface, which dries as a yellow or black crust, usually several ulcers form, each exuding this peculiar fluid.

The course of the disease is not rapid, and may progress for twenty years without causing more than marked discomfort. No treatment has been found outside of a radical operation, which many times was not successful. The disease is apt to become epitheliomatous after several years, and may progress more rapidly.

Reasoning from the effects of the X-ray upon eczemiteous conditions that it should be of value in this disease, I tried it upon a well advanced case in 1902, and was gratified to see a slow but permanent improvement take place, until the patient was to all appearances cured. Since then I have used it on three more cases, and with the same good results, until I am sure it is the most satisfactory treatment for this condition.

The success of the ray in this disease has been verified by numerous operators.

Dr. J. Belat, in Archives of Roentgen Ray, August 7th, reports two cases cured, and refers to a report of similar cases of his in 1905. Dr. F. Bisserie, Archives Roentgen Ray, October, 1906, reports 9 cases treated with seven cures and two failures.

THE PHOTOGRAPHIC PLATE.

We must regard the photographic plate as a sheet of glass covered with a sensitive film made from innumerable sacs of gelatine, each containing a small grain of a sensitive silver salt. By certain processes the bromide of silver is forced into an unstable molecular structure, which upon exposure to light or radiant energy is reduced to a more simple compound. The bromide reacts chemically

to certain reagents in a different manner, depending upon the fact of its having been exposed to light or having been kept in the dark.

When a pencil of light strikes a film, the silver is changed in its physical arrangements in such a manner that it is reduced to metallic silver by means of an oxidizer or developer, while the rest of the film is not affected by the same agent, but may be dissolved by other agents.

Plates for skiagraphy are usually made for the purpose, and differ from those used by ordinary photographers, by an increased thickness of the emulsion; in other words, the coating is much richer in silver and is about double the thickness of the ordinary plate.

For the lighter portion of the body the so-called landscape photographic plate may be used and with much satisfaction, we are compelled, however, to use the special coated X-ray plates where we have heavy body work to do owing to the relative lack of density of the part skiagraphed.

The Method of Handling Plates—When we desire to use a plate it is removed from the box in a dark room, and placed in an envelope of dark needle paper, with the seams of the envelope at the glass side of the plate. This in turn is placed in an envelope of yellow gold post office paper, usually by inverting the plate and slipping the open end of the black envelope into the yellow, care being taken to keep the seams of both envelopes to the back side of the plate. These operations are preferably carried out in a perfectly dark room, and until the operator gains sufficient skill to do this in total darkness, a very small dark-room light can be used, although it must be remembered that an X-ray plate will fog from the safest red light we have in about thirty seconds.

Methods of Exposure—Where possible the exposure should be made in the prone position, owing to the fact that this position gives the very best position where the patient can lie still. If it is possible the plate is placed un-

der the part upon a perfectly level table and the body fixed with sheet or sand bags to prevent motion. If the patient is timid or a regulating tube with a short gap is used, the current should be carefully turned on to avoid the snapping or sparking necessary to adjusting, otherwise involuntary movements are bound to take place and a loss of sharpness may result.

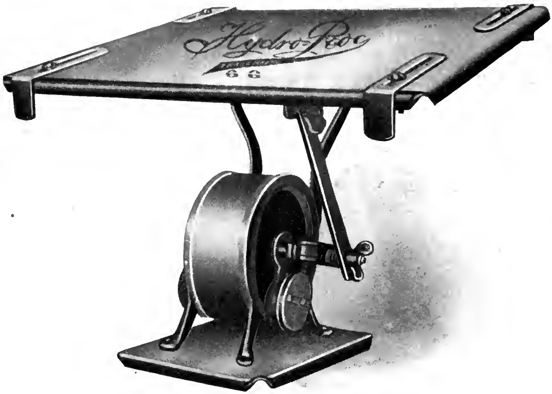
Time of Exposure—This will depend on the part to be skiagraphed, the size and character of the apparatus and the kind of developer and plate that may be used. It is a good rule to give a liberal exposure, and generally not at the full capacity of the apparatus. I have made it a rule to set my spark gap at the penetration desired, and turn on the current slowly until the tube has adjusted to the vacuum desired, when nearly the full force of the apparatus is turned on from one to ten seconds and off again quickly. This generates the higher waves, polarizes the body reducing resistance, and when the desired vacuum is obtained a powerful and quick exposure is made at approximately the correct degree of penetration. This gives beautiful contrasty negatives and has been found very satisfactory. Where we desire to outline an organ in motion, as the heart, lungs or stomach, the tube must be adjusted correctly and an instantaneous exposure given. This is possible with nearly all types of apparatus now sold on the market.

Development—When we have exposed our plate we must put it through a process called development. Certain reagents have an affinity for polarized silver bromide, and while their name is legion, we shall give the formula of one that has not been found wanting in over ten years' work. It requires from five to twenty minutes to complete the operation and a very liberal exposure, but works very clear and gives a very beautiful plate.

Developer—

Edinol	4.
Hydrochonin	12.
Acetone Sulphite	45.
Potassium Carb. dry C. P.	100.
Potassium Bromide	.12
Aquae Dest.	1000.

This solution can be used without dilution, or one-third water may be added to give a finer grain plate with



A WATER ROCKER. TO DEVELOP PLATES

less contrast. It never pays for an amateur to begin experimenting with developers, as by so doing he will never reach perfection with any. It is better to stick to a good formula and try and adjust other conditions to this fixed one and we will be able to locate our mistakes and correct them with less trouble.

Temperature in Development—All chemical reactions have a critical temperature and it is so in photography. We must keep our solutions between 60° and 70° Fahr. At 60° we get a coarse granular deposit very contrasty, and as the temperature raises we get a finer grain with more detail, until at 75° the gelatine begins to dissolve

in the strongly alkaline solution and we get a very flat negative with a wealth of detail but so faint it is of no value.

Spots on Negatives—Many amusing mistake are made by new beginners when they discover what they take to be calculi on newly developed plates. These spots are due to lack of skill in flowing the plate with developer so that it hits the plate in spots. This is a difficult knack and requires plenty of practice to do it skillfully. It is better to use plenty of solution and the plate should be covered with a sweeping motion so that the solution does not rest one instant until the entire plate is wet.

We have learned that finger marks on the dry plate will cause it to develop in spots, owing to the gelatine absorbing grease from the skin.

Dust Spots—These appear as minute specks and can be avoided by fanning the plate with the envelope just before placing it therein.

Time of Development—It is a good plan to carry the development until the plate on the back not protected by the body has turned a jet black and if the plate has been correctly timed the half tones around the bones will begin to grow dark. This is ascertained by turning the plate over and looking at the back occasionally and when we are satisfied that we have gone far enough pour off the solution and rinse the negative in two changes of water and place in the fixing solution.

Fixing Bath—If the operator is not doing a large amount of work a plain bath of sodium hyposulphite, one ounce to four ounces of plain water made up daily as required, gives the best satisfaction as the fresh solution has a hardening effect upon the film and fixes without stain.

The plate is left in this bath for ten minutes and is then washed in rinsing water for about one hour. The object of this bath is to remove all unpolarized silver from the film so as to make the negative permanent when

exposed to the light. It removes all silver not reduced to metallic silver by the developer.

If the operator has a great quantity of work to do the acid fixing bath may be used, the formula of which may be found with each package of plates.

Drying of Negative—Much skill is required in drying a negative properly. It must not be set in a place that is too hot or the film will run, showing some dislocation, neither should a cold place be used or the gelatine will show grain. It is usually best to set it on edge with a gentle draft passing across the plate and not disturb it until it is perfectly dry. If it is necessary to look at it, care should be taken to set it back in the same position as it is of prime importance to have the whole film dry at the same rate of speed to obtain the same density.

Printing of Negative—I have been unable to find any developing process except the celluloid films that give the real value of a skiagraph negative. The printing out papers when exposed to the northern light gives the best value of any process and this can safely be left to the photographer, as this gentleman is much more expert along this line.

Division of Labor—The question has been asked of me many times by physicians who contemplated taking up this work as a secondary part of their business, "Why can't I let the photographer do all the hard work and I make the exposure?" A little thought would have made the objection plain. The exposure is one of the most important parts of the process and must be made to harmonize with the balance of the operations or failure will result. Tubes are constantly changing in vacuum, people with a varying density of tissue are found and success can be obtained by careful attention to details and this is not possible where the responsibility is divided.

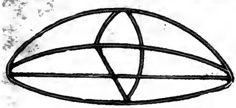
Cleanness in Photography—Slovenly work in photography is as culpable as dirt in surgery, and it is only by using clean solutions, clean trays and graduates, and being very careful not to contaminate solutions by the hands,

that any success can be had. The dark room must be clean, free from flying crystals and dust and all utensils should be thoroughly cleaned out after use.

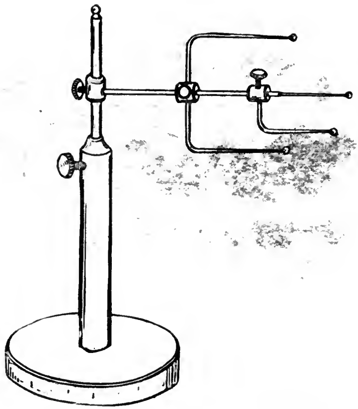
Dark Room—For some reasons physicians usually select a closet for this purpose, with no ventilation and about enough air to last them for about ten minutes, and it has been called to my attention a number of times where they have used a kerosene lamp or gas to light their lamp; several deaths have taken place from this folly, the fumes suffocating the operator before he was aware of the danger. Under no circumstances should gas be used in a dark room or any other open light. Where this source of illumination must be used it is better to cut a window and place the light outside. If possible a room 10 x 12 feet should be selected, with running water and some means of ventilation by forced draft. In this you can work with comfort with no danger to life or health and the temptation of shortening the process from discomfort will cease. We cannot do good work where we are uncomfortable and it is useless to try.

Examination of Negatives—One of the most beautiful methods is a box illuminated with electric lights with some resistance in the current to cut down the voltage of the lamps. By this means we can control our source of light and can bring out the beautiful graduation of a negative in a way to allow us to judge clearly. The observer should be in a perfectly dark room with the box as the only source of illumination, in this way we can show our plates to good advantage to an audience if desired.

SHOWING AN ENCYSTED SARCOMA OF TIBIA.

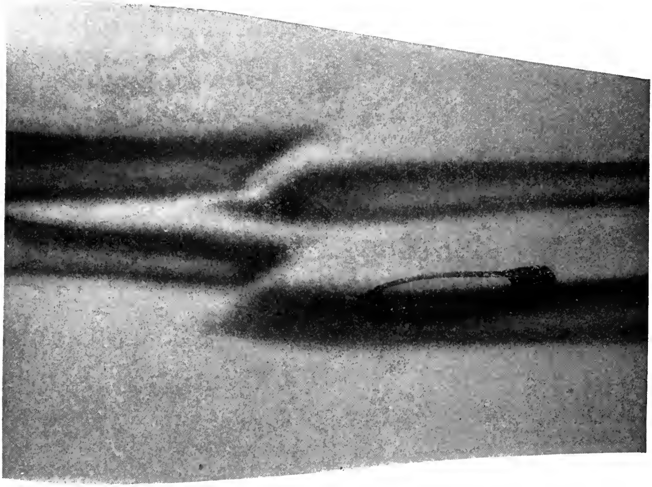


FOX'S CONFORMER FOR EYE LOCALIZATION A GOLD WIRE BASKET TO FIT THE EYE BALL.



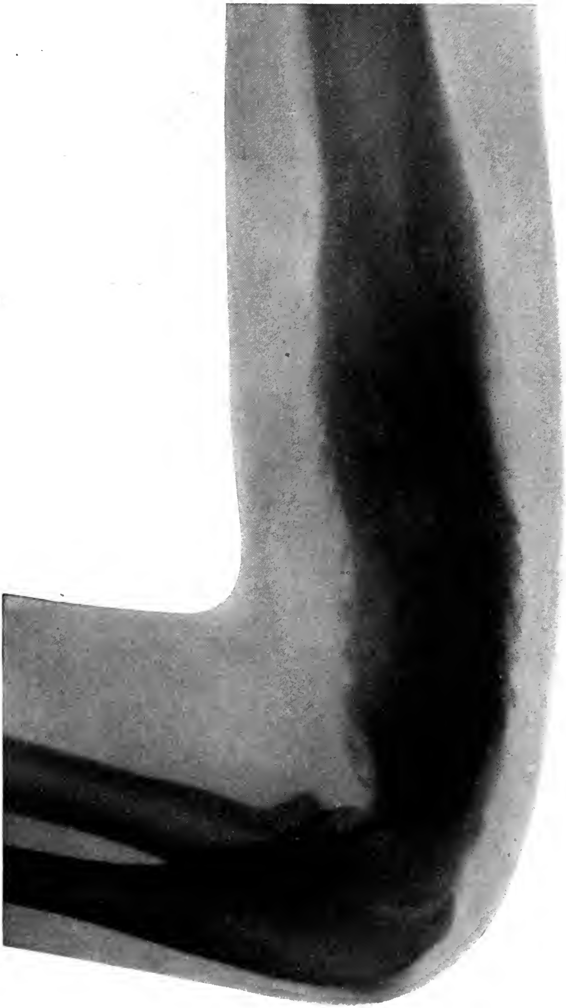
THE AUTHOR'S LOCALIZER FOR EYE WORK

DISLOCATION OF ELBOW.



A VIEW THROUGH A PLASTER CAST. SHOWING MUCH DISPLACEMENT.

OSTIO-SARCOMA OF RADIUS.



OSTIO-MYELITIS. SUPPOSED TO HAVE BEEN RHEUMATISM.

TWO VIEWS OF SAME LEG. SHOWING WHY THE PATIENT HAD PERSISTENT PAIN AFTER INJURY.

THE X-RAY AS A SPECIALTY.

Of the many features in medicine few, if any, require more hard study with experimenting in order to work with some degree of precision in a very limited sphere. That the knowledge can be acquired by the general practitioner is self-evident providing he is willing to spend the time necessary and has a wealth of clinical material to work with. That it is advisable for him to do this work is a question that must be settled after all the facts are at hand. It is certain that no one, no matter how skillful, can make a success of this specialty when he has to depend on his own practice for clinical material, to say nothing of the time the operator must spend keeping his apparatus in proper working order and the many hours he must put in, in the dark room, in order to do his work properly.

If this part of the work is well done very little time will be left for a busy general practice.

It appears to me that we must soon change our system of doing business in order to present to the public a united front in each locality in which the entire medical staff in each locality will stand shoulder to shoulder helping each other in diagnosis and treatment.

For all the physicians in a $500 community to expend $5,000 on medical apparatus that no one knows how to use is a shameful waste of energy and of the doctor's substance. Much better results would ensue if they would unite and buy a common apparatus and delegate its operation to one of their members; in this way he might get enough cases to become skillful and reflect credit upon the judgment of his supporters. To purchase an apparatus simply because the physician has a case where he thinks it might be useful does not indicate that he has common sense. From a radiotherapeutic standpoint, cases are few and far between in which this treatment is indicated, and if the general practitioner sees ten of them in a lifetime he is an unusually busy man, and as for mak-

ing a skiagraph only occasionally few men can do it successfully. I hope to live to see the time when an epidemic of common sense will strike our profession. In that time I expect to see all the physicians in a community that amount to anything combined under one business management with everyone of them a general practitioner, yet each skilled in one of the different specialties.

Medicine should not be on a competitive basis, neither should medical men be enemies to each other. The combined medical brains in the average community is none too great to give the public any more than they are entitled to have from our profession, and under the present system it is evident that the public is not getting a square deal and knows it. Thousands of our patients are not going into the Faith Cults just to be perverse, but because our profession are not able to give them satisfaction under our present system.

We must organize a machine to do business like the rest of our community in order to have capital enough to transact it properly and to do business more economically. To be compelled to send cases away from a particular county reflects upon the ability of the whole medical fraternity who resides therein, it shows that they are disorganized and disinclined to study. For the general practitioner to attempt to do laboratory work or even to use the X-ray as a side line only makes him ridiculous. No one man's head is large enough to grasp the technic and truth behind all the specialties and it is absurd to even try to do it.

The general practitioner should aim to perfect himself in physical diagnosis and be enabled to call on skilled helpers when he requires their services, or what would be even better, have them as a part of his business machine, so that no case of obscure disease will be overlooked. In this way each man must continue to grow in brain power by association and example even if under the present condition of affairs he deteriorates yearly, no man is so small mentally but that others can profit either by his

success or failure. By a business organization of this kind we can cover the entire field of medicine and if necessary have the best and latest equipment and if the needs are pressing, a hospital.

An organization of this kind allows each member a yearly vacation for rest or study as may be thought best and each year the concern will grow richer in knowledge and more valuable to their respective communities.

HIGH FREQUENCY CURRENT.

We must look upon the high frequency current as an alternating current of high or low potential, oscillating at a rapid period. To secure these oscillations it is necessary to charge a condenser and discharge it through some inductance or conductor of great capacity. This gives rise to a series of surges from one condenser to the other until eventually an electrical equilibrium is established through the inductance.

If we fix an elastic rod firmly, and set its free end to vibrating, we will find that it will travel just as far the other side of the central point as we started from, and will go through a series of to and fro movements, gradually losing in amplitude until eventually it comes at rest. The oscillation acts in the same manner in a condenser. When it is discharged the positive charge goes through the inductance to the negative at a high velocity, reversing the potential of the negative side and inducing a negative upon the original side of the positive so that it rushes back and forth until an electrical equilibrium is established. These oscillations are extremely rapid, running in medical work as high as two million a second. This may appear incredible to some readers, but are in reality very low, owing to the fact that visible light oscillates as high as four hundred billion a second.

In our work with this form of energy we are enabled to change the number of oscillations or the amplitude of the waves at will. If we increase the size of our condenser and decrease our inductance we increase the number and amplitude of our waves and conversely we get a lower frequency with less amplitude with more inductant and less condenser.

In our new form of commercial apparatus we can obtain frequencies all the way from 200,000 to 2,000,000 a second.

HIGH FREQUENCY CURRENTS.

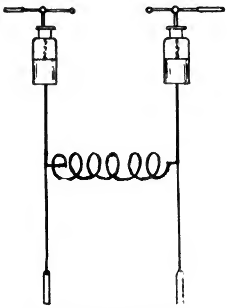
The theoretical possibilities offered by high frequency currents have been known since the work of Prof. Hertz, and become intensified by the bold deduction of Oliver Lodge, stimulated electricians to perfect apparatus and investigate the marvelous physical phenomena which attend the production of alternating currents of high frequency, great amperage or excessive voltage.

A new world of possibilities was opened in both medicine and the arts, by the commercial production of these currents. In 1889 Nikla Tesla, one of the greatest electricians the world has ever seen, became interested in this subject and spent much of his valuable time, and many thousands of dollars, carrying on an investigation of the physical properties of these wonderful currents. A work that began in scientific curiosity and has proved a life work of love for the benefit of mankind, a work that could not be finished in one man's lifetime. He started with the mere phenomena of a vacuum tube effects, and has now attained the extraordinary effect of drawing a flame sixty-eight feet long from his transformers, and so inconceivably rapid in frequency, that the human mind cannot grasp the results.

He has succeeded in transmitting several horsepower for miles through the surrounding medium without metallic connections, and produced disturbances in the ether that unquestionably have gone to the extreme limits of our solar system. He has transformers of such large volume and low voltage, that metals melt like water, while many explode with violence. These experiments interest all of us from a physical standpoint, but to a physician his further discoveries are more interesting. He found that these currents, while having the most terrific effect upon metals were not dangerous to human life, also that the body became a condenser, and generated a counter electro-motive force that protected it from instant destruction from the enormous currents that may be transmitted through it.

Electro-therapeutists reasoned that some valuable results should follow the use of this modality, and numerous attempts have been made by manufacturers to devise some apparatus to supply enough energy for electro-therapeutic treatment. They attempted to follow the Tesla principle until it was found impractical to generate enough voltage and maintain the insulation properties of the coil, and eventually they fell back upon the combined principal discovered by D'Arsonval and Oudin. Alfred Deàn of London combined the solenoid of the former with the resonator of the latter, and for the first time enough current was available for experimental purposes, although it falls far short of what is required for active work.

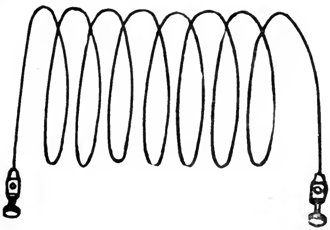
Construction of Apparatus—We have another way to obtain the X-ray that is of interest, although it had never obtained a practical form until the Victor Electric Co. brought out a special machine for this purpose. If we take an alternating current of, say sixty cycles and increase the E. M. F. we will find that when we attain an electro-motive force of 30,000 thousand volts, that we have sufficient energy to charge a suitably constructed condenser. If the internal layers of this condenser are charged by means of this current a spark will pass between each side through an adjustible spark gap.



D'ARSONVAL'S METHOD

This is a disruptive spark and gives rise to oscillation in the outer layers of the condenser. These currents are known as D'Arsonval high frequency or "B" current. If we allow this current to discharge through a solenoid, helicoidal or spiral coil of large capacity, induction is excited, which hinders, impedes or retards the speed with which the current passes through one of the outer condensers, causing a series of surges or waves to travel back

and forth in the wire. If we attach to this coil a tap or shunt and place our patient within this shunt, we cause the body to act as a condenser, and the oscillations are so rapid that it it is called high frequency. The alternating phenomenon is different from that observed at a low period. Where we have an even period, with rythmical changes of polarity and volume, the potential shifts to different parts of the body. With the D'Arsonval current the frequency and volume are irregular, due to the distance of the prime electrodes from each other, and the size of the condenser as well as the coils of the spiral that may have been tapped with the shunt. When a condenser is fully charged the surrounding medium is polarized and under a terrific strain and when it is allowed to spark across suitable terminals, we have a pilot spark of terrific speed and energy, the conducting medium between the prime conductors is completely polarized and driven apart, the atmospheric molecules are polarized between the gap and a vacuum is created in the path of the spark. The effort of nature's laws to establish a state of equilibrium gives rise to a series of reverse potentials, that are imparted to each side of the condenser which cause oscillations to take place in the impedence coil; each becoming more feeble than the preceding one until a state of rest is established. These oscillations have been photographed upon a rapidly revolving wheel and are known to exceed two million per second.

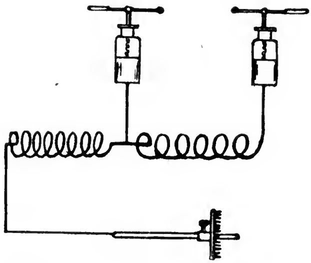


SOLENOID.

By charging the condensers rapidly, we can keep the volume up to highest value. A curious phenomenon is

noted with this current. Conductors in the ordinary sense of the term, seem to resist this form of electricity, and at the best it only seems to travel upon the surface of the large conductor, but insulators offer little or no obstruction to the penetration of the current, it being possible to pass this current through four inches of solid glass, if it is insulated around the edge of the plates by turpentine to prevent the current from flowing over the sides. If we tap the solenoid with one wire we may carry it to almost any distance, and we will find the surging present and like sound, we will find that the wire has nodes that vary according to the frequency. In the construction of this apparatus this point must be kept well in mind and the node caculated so that it will not come at the terminal electrode in order to get the greatest therapeutic effect. This can be varied within wide limits by varying the size of condenser and the length of the spark and the volume of the exciting current. It is possible to construct this kind of apparatus so that it can be run in periods by paying proper attention to synchronizing the condensers. There are many different methods of constructing this form of apparatus and each form gives a different result. Nikla Tesla adopted a form of a central resonator of fine wire surrounded by a coil of very large wire as a solenoid, and he found that the surges through the primary wire caused a rotation of the polarized particles in the surrounding medium, which cutting through the turns of the secondary coil developed a high frequency current. Small types of this form have been used in medicine, but so many difficulties were found insulating the primary from the secondary, that eventually the form developed by Oudin, and improved by Alfred Dean of London has survived the experimental stage and is adopted by physicians as a fairly reliable source of energy and gives a valuable therapeutic current. This apparatus consists of a horizontal drum of wood around the lower end for about eight inches; an open solenoid of copper wire of No. 6 B. & S. gauge is tightly wound. The end of the

large coil is continued by a coil of fine wire No. 22 B. & S. upward on the drum for a distance of 24 inches and the terminal brought out on the top to connect to the electrode. Two Leyden jar condensers are mounted in the base and a suitable arrangement to tap the layers of the large coils, controls the frequency and volume. An adjustable spark gap completes the apparatus. It may be excited by any large step-up transformer, static machine or X-ray coil. Many of this type are playthings, being altogether of too feeble power to use except for surface troubles. Their place is gradually being taken by the more powerful Victor apparatus, which is large enough to deliver more energy than can be borne comfortably. The Oudan apparatus was only a make-shift, an attachment to apparatus already installed. The new Victor type is especially calculated for this work, from the ground up. Taking in the commercial currents, either alternating or direct, and stepping it up to 30,000 volts. This is used to charge an adjustable condenser, while this in turn is discharged through the inductance coil, to excite oscillations in the resonator. In this form very little current is lost, and as they can be constructed for a reasonable price, there is no limit apparently to the amount of current that can be delivered by this style of apparatus, except its size.



D'ARSONVAL'S METHOD GIVES A LOW VOLTAGE, ITS POTENTIAL BEING LIMITED TO THE CURRENT THAT CHARGES THE LEYDEN JARS, AND IS CONTROLLED BY THE LENGTH OF THE SPARK GAP. OUDAN-CONSTRUCTION PARTLY OVERCOMES THE DIFFICULTY BY ADDING MANY TURNS OF SMALL WIRES RAISING THE POTENTIAL SO AS TO GET A BRUSH DISCHARGE.

These coils have been constructed in such a way that an entire room has been converted into an apparatus by

winding eight layers of No. O B. & S. wire around the outside of the room and continuing the solenoid with fine wire to the ceiling. The entire room is subjected to a turmoil from the oscillations that take place from the reverse polarity in the neighborhood of the coil or a secondary may be placed at any point in the room by adjusting the condenser so as to throw it in resonance with the oscillation of the primary; it may be used for experiment or treatment.

Many spectacular effects are noticed with this form of apparatus when charged with the step-up transformer. No sensation is experienced when in contact with the apparatus owing to its high electromotive force and period of oscillation rendering the body a good conductor. If a break occurs, however, a beautiful effluvia will spring from the apparatus and surround the body like a halo, making a grand, sublime spectacle in a darkened room. If the experimenter grasps a string of incandescent lamps they will come up to full candle power with no sensation to the holder, energy enough passing through the body to cause death instantly if stepped down to a low voltage and period. If a secondary coil is made from a drum shell the effect may be studied in the physical field.

A strip of tin inserted in the center of this solenoid will explode with a loud report; steel is brought incandescent in a fraction of a minute and will run like water. Explosives of all kinds are detonated; motors may be synchronized with the apparatus; other apparatus may be tuned to respond in unison with it and it has been found practical to transmit energy great distances from the exciting apparatus. Practically five horse-power has been transmitted three-quarters of a mile with the loss of only forty per cent. by Nikla Tesla. It is a wonderful sight to see this puny man draw a thunderbolt sixty-eight feet long from his transformer of such a high period that the very nitrogen of the air is destroyed, liberating enormous quantities of nitrous products. Walking unconcernedly around his laboratory of nature's mysteries as though

he bore a charmed life, this wizard maintains that the disturbance of his transformer passed completely around the world in four seconds, and may again be detected in his laboratory. Many of his experiments would seem to prove his conclusions.

Safety of High Frequency—It seems a paradox that human life can resist this turmoil where metals are instantly destroyed. Still it is perfectly safe to place your head into any of these drums, as the body has the ability to act as a condenser generating a counter electromotive force that prevents its instant destruction. This factor is a valuable one in high frequency treatment as the body is a highly charged condenser that responds to each oscillation of the exciting current. Apparently the current has its selective action upon the nervous system and a peculiar phenomenon is noticed by all experimenters after a prolonged seance with this form of energy. Extreme lassitude is noticed with a pronounced anesthesia of all peripheral nerves and frequently with an overpowering desire to sleep. Considerable speculation has been caused among operators as to the ultimate results regarding life, if the current was used without caution.* The intense violet light emitted from vacuum electrodes and the nitrous products liberated from the air has made it a valuable current to use for skin affections as bacteria are rapidly destroyed, if within the sphere of influence of the active field. Distinct nutritive and sedative effect is noted upon nerve tissue when subjected to this form of motion and its persistent use will cure many forms of degenerating neuritis where all forms of treatment have been found wanting.

It has been much used for acne upon the face of young people and with great success. It may be depended upon to stimulate many obstinate chronic ulcers and has attained considerable success in insomnia. Repeatedly, reports have been made in different parts of the world regarding its value in tuberculosis, but generally it has been disappointing, being much inferior to the X-ray in this

*NOTE. This is now disputed by many observeas.

disease. A great deal is possible, however, in this form of energy by using as the exciting force the commercial alternating current. By using large quantities of current in the primary, phenomena are excited that careful investigation may find beneficial in many so-called incurable diseases. It is generally known that this step-up process may be continued a number of times by charging different sets of condensers and using their oscillation to excite other coils. It has been carried so far that the oscillations in the surrounding medium give a wonderful fluorescence showing that the alternating turmoil has approached the period that the human eye detects as light. No one who has witnessed this unearthly glow brought up out of utter darkness, can appreciate the splendor and sublime effect of a light, that seems to come from nowhere, and goes nowhere, the utter absence of shadows making an ugly demoniac face of an ill-favored human being take on a splendor that transforms it into a grandeur never before seen on earth. Light radiates from everything; it is everywhere; color softens down and blends with the surrounding objects and when the vision fades the spectator feels like a lost soul in utter darkness. I never expect in all my life to see a more sublime or awe-inspiring vision than was produced by these transformers when run in series, and I cannot help thinking that if money were available to develop this work thoroughly, medicinal qualities would be found, undreamed of by man.

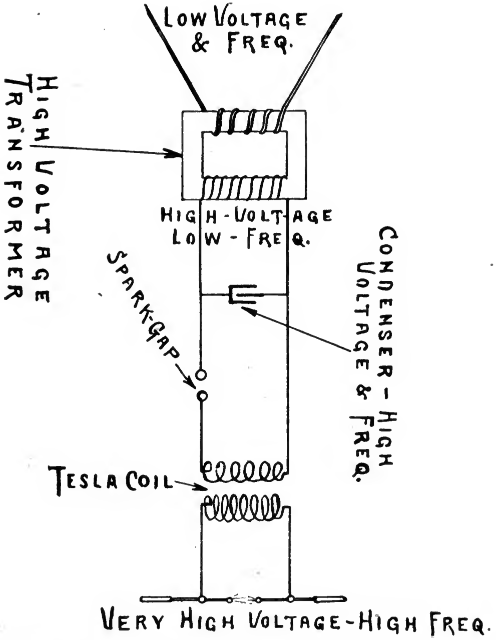
This phenomenon was produced by stepping up the current through three transformers.

INDUCED OR D'ARSONVAL CURRENT.

These are obtained by tapping a short circuit from the inductance coil and are not applied with vacuum electrodes but are given with sponge or metallic electrode. They are currents of enormous volume but low potential and cause profound nutritional changes.

Auto conduction or **general D'Arsonualization.** The patient is not included in the circuit but is placed in a large

solenoid through which the oscillation of the condenser is allowed to flow. This produces an electro static field that synchronizes with the oscillations in the solenoid. This causes the body of a properly insulated patient to act as a



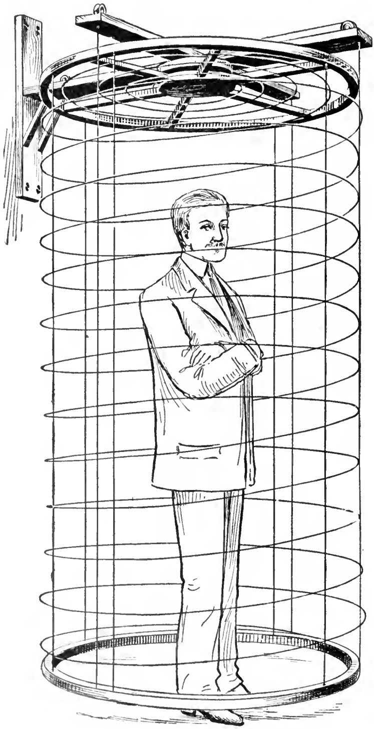
SHOWING THE MODERN VICTOR SYSTEM OF CONSTRUCTION IN HIGH-FREQUENCY MACHINES. THE SECONDARY OF THE TRANSFORMER DISCHARGES DIRECTLY THROUGH THE SOLENOID. THE AMOUNT BEING LIMITED ONLY BY THE SIZE OF THE SPARK GAP AND THE OUTPUT OF THE TRANSFORMER.

condenser whose electrical charge is swayed with the frequency of the current. If we approach the body in any direction with incandescent lamps they are immediately lighted. While in a dark room a radiating effluvia is seen springing from the body in all directions.

If we approach, the body sparks or an effluvia is drawn from it, or by attaching the wire to the body under treat-

ment, we may take it any distance and will find that the energy will be sufficient to light a string of incandescent lamps.

Auto Condensation—We attached one pole to a metallic plate covered with an insulating cushion and allow the patient to lie thereon while he is connected with the other pole of the apparatus. This makes him one side of a condenser, and the metal plate becoming the other side,



AUTO CONDUCTION CAGE

while the cushion is the dialectic. This makes the body respond to each variation of polarity, and has a profound

effect on the sympathetic nervous system. Nitrogen metabolism is hastened, while a considerable lowering of blood pressure supervenes.

PHYSIOLOGICAL EFFECTS OF THE CURRENT.

Nervous System—The discovery of Tesla that these currents were apparently free from deletrious effects upon the nervous system first suggested their use as a therapeutic measure. Apparently these currents can oscillate through the nervous system without any appreciable effect for a considerable period of time. Further investigation shows that it does have an effect as it lowers the irritability of the nerve to the ordinary stimuli and tranquilizes the sympathetic nerves (vasomotor relaxation). This is more noticeable in disease than in health. The effect seems to be the same on both the sensory and motor nerves.

While lecturing on and demonstrating these currents one evening a severe rainstorm came up, that prevented a large part of my audience from enjoying the display, and they requested me to repeat them for the belated spectators later in the evening. I noticed in a short time that I was having considerable difficulty in keeping awake, while my legs were rather inclined to drag while walking, the effect became so profound that it became necessary for me to close my lecture and it was with the greatest difficulty that I was able to get home, where I fell into a profound slumber for twelve hours. For some time afterwards my legs showed a disposition to drag and were numb for several days.

Local Sensation—A sense of extreme warmth is noticed in the neighborhood of the electrode, this characteristic sensation is produced alone with the high frequency current, yet no local injury is suffered from prolonged contact nor any muscular stimulation as long as the electrodes are in perfect contact.

If a small air gap is allowed between the electrode and a part of the body a succession of small fine sparks

are given off in the air space, that stimulates active muscular contraction and causes a disagreeable sense of warmth with some smarting, later being followed with a local anaesthesia and myasthemia or lessened muscular irritability.

Muscle Reaction—While a muscle will respond to a broken circuit and sudden contact, it will not do so violently except in currents of a high tension and low amperage. They will react moderately to all forms for a short time until they gradually lose their irritability and a condition of quietude or myasthemia or lessened muscular irritability is brought out. It is believed that this peculiar condition of relaxation of the muscular system is responsible for the fall of blood pressure noted in prolonged auto condensation.

In from ten to fifteen minutes while using two amperes of current a delicious sense of relaxation will be noticed, while the skin becomes moist and eventually drops of perspiration will begin to roll from the face. The skin takes on a rosy hue while the lids droop lower and lower until eventually they close and our patient is sound asleep.

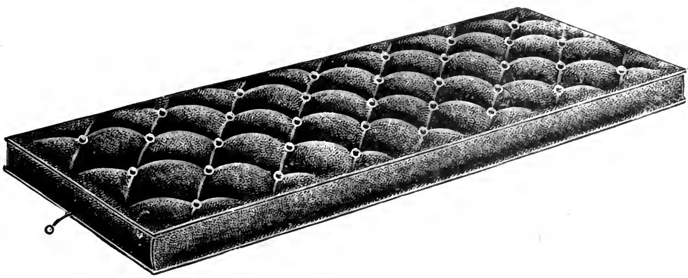
Blood Effects—These are very marked upon the blood pressure. A patient with an abnormal pressure will drop 20 to 30 mm. in a treatment of fifteen minutes with two amperes of current. In some cases it is a transient affair regaining its former high standard in a few minutes, but as a general rule a persistent course of treatments will gradually lower the pressure close to normal limits.

Experimental work done on rabbits shows a dilatation of the blood vessels of the ear with a marked raise in pressure and a sharp contraction a few minutes later.

Metabolism Effects In—The remarkable effects of auto conduction and auto condensation upon nitrogen metabolism has attracted considerable attention from different observers and as usual in anything electrical the conclusions are not always well taken. When an operator gets remarkable results in one particular case, it should not be stated in a didactic

way that the results are applicable to all people. When we apply the high frequency current by general treatment to a person in normal health, a very slight effect or none may be noticed upon nitrogen elimination. Yet if we apply the same treatment to a patient with a high blood pressure with a nitrogen elimination of say 7 grams daily, a treatment by either of the general methods will yield from 15 to 20 grams in the next 24 hours providing a defective thyroid gland is not at the base of the trouble. This result can be accomplished by medicinal means as well as by using the current, yet we will not get the sense of well-being following the drugs that usually follow the electrical treatment.

Mechanical Effect—It is very improbable that the enormous electrical charge of the body under treatment being swayed under the varying potentials of the solenoid should not produce some mechanical effects. If it should be so under these conditions it would be the only instance in the physical field. Some transformation of energy must take place and that this is so we can assume from the increased deep breathing with the increase in the elimination of urea and carbonic gas. The general sense of warmth of the body would go far to indicate the absorption of energy and while no actual increase of temperature has been noted, this undobutedly is compensated for by the perspiration that ensues. It is safe to assume that



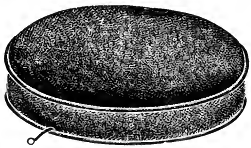
SHOWING VICTOR CUSHION, TO CONVERT AN ORDINARY TABLE TO A HIGH-FREQUENCY COUCH.

an absorption of energy can and does take place and it is unquestionably due to this fact that much of the good effects of the current is due.

Chemical Effects of the Current—That currents carrying so high a value in amperage can oscillate through the human body without producing chemical reactions is unthinkable. The steady increase of hemoglobin in cases of anemia with the constant raise in total urinary solids, while the toxic properties of the urine gradually increases, shows that profound changes do take place. If the currents are given by a pointed electrode with a suitable spark gap, a destructive chemical action is brought into play, rapidly destroying tissue by dessication.

Bacteria Effects Upon—Intensified effluvigation has been found effective in destroying many varieties of bacteria, the effects probably being due to the nitrous products elaborated by the current and not to the effects of the current itself.

No special method has been devised, however, to take advantage of this property in treatment with the exception of the glass electrodes, some of which have a rock crystal bottom in order to allow the violet and ultra violet rays to escape. In general it may be said that they are disappointing, not giving the results expected and as a general rule are inferior to other well known methods ot treatment.



SHOWING VICTOR CUSHIONS FOR USE IN AN ORDINARY CHAIR, FOR HIGH FREQUENCY.

At times a brilliant result will follow their use, but it is one of those methods in which startling results could hardly be expected. The whole subject of the effects of high frequency upon bacteria is involved in contradictions with equally as good men on both sides of the question.

Unquestionably some observers like Charron, D'Arsonval and Haller have succeeded in modifying the growth of bacteria within certain limits but not enough success has been obtained to justify any thought of using the current for this purpose.

High Frequency on Toxins—While the effect of this modality upon bacteria may be open to question, the results upon toxins has been pronounced, high frequency currents being allowed to run through a diluted solution of toxin for thirty minutes has been known to destroy much of its violence, upon this statement we have the authority of Dubois, D'Arsonval, Charron, Phisalix and others too numerous to mention.

The toxins from all germs tested, as well as cobra venom, showed marked diminution in toxicity after being in the electro static field of a solenoid. The particular way in which the currents bring about these changes in the toxins is not well understood but are believed to be both mechanical and chemical, owing to the violent oscillations undergone by the atom and the chemical value of the current that is passing. The effects of the current upon toxins is not constant, the effect being governed by extraneous conditions not always under control.

WHY THE VIBRATORY CURRENTS ARE NOT FATAL.

Considerable speculation has been indulged in to account for the fact that currents carrying so great an amount of energy are not immediately fatal or at least why they do not accomplish harm in their passage through the body.

Several hypotheses have been advanced to account for these conditions, and among those who have obtained some recognition are as follows:

1. The conductor Impedance Theory.
2. The Theory of Extended penetration.
3. The Theory of Inductive reactance.
4. The Theory of Limited excitability.

The conductor impedance theory of Vigouroux, Galileo Farraris and Ratzekowsky has been one of the favorite explanations of this phenomenon. When a continuous current traverses a large conductor the lines of magnetic induction pass through the non-conducting medium surrounding it, a certain percentage of the lines of force pass through the conductor itself, so that the lines of force are greater at the center of a conductor than at its outside. If such a conductor is used for alternating current of a moderate frequency, the currents running to their flux being periodical do not have time to penetrate to the interior of the conductor, but confine themselves to its surface. This increases the resistance of the conductor and diminishes the number of lines of force passing to its interior.

Maycock has named this phenomenon "Conductor Impedance."

Induction of the conductor traversed by high frequency currents develops eddy currents in the interior of the conductor of the opposite sign so that a ribbon conductor of the opposite sign offers less impedance to currents of high frequency than a round one as there is a smaller drop in potential.

Nikla Tesla advanced the theory of extended penetration, he believed that these currents spread out in all directions from the electrodes and then passed directly inward. This theory is rather far-fetched, as may be seen by using electrodes of different sizes.

Texeira advanced the theory of inductive resistance, which seems to have won many workers to its support. All wave forms of currents which travel on the surface of conductors induce currents in its interior of the opposite sign and in the case of high frequency currents with their short period their duration is too short to break down the inductive resistance of the conductor.

D'Arsonval advanced the theory of Limited Excitability, he has many followers in Europe and there is much experimental evidence to bear out his contention.

Experimentally we know that muscles and nerves will respond to wave stimulation if it does not exceed 10,000 a second, beyond this number they seem insensitive.

It is very probable that all of these theories leaves much to be desired. It is very probable that the true explanation is confined to the simple fact that the condenser charge retained by the body acts by transferring the energy from one side of the circuit to the other, and that conduction, as we understand it in electricity, does not take place, that the energy is transmitted in the body in the same way as light is transmitted through the ether by the oscillation of its electrical change, therefore no physiological stimulation can take place without some irregularity in the periods take place. It is probable that much confusion results from the effort to make the high frequency currents correspond to our ideas as conceived from our knowledge of lower wave forms used in commercial work. In the later forms the period is so low that electrolysis results from the passage of the current owing to the relatively low potential, and the rather high resistance of the human body, we can realize its absurdity if we should attempt to compare the commercial alternating current with light, to pass one through glass and the other through copper and then by trying to reverse the process we will begin to realize that, while we are dealing with electrical phenomenon, yet they have little in common even in spite of the fact that one can be transformed into the other or back again at will.

High Frequency currents are a thing apart from all other forms of electricity and do not obey the same laws as the other currents used either in the arts or medicine. That the currents do penetrate the interior is well known and proven by the increased nitrogen metabolism that invariably follows their use. This should be satisfactory to physicians without losing sight of their efficiency in medicine in a fog of theory that does not explain things clearly.

A more extended discussion of these theories may be found in the excellent work by Crook.

THE HIGH FREQUENCY IN CANCER.

The Fulgration Method—The hopes entertained by many operators that in the high frequency we would find a cure for cancer seemed destined for a few years to disappointment, as with the exception of improvement in nutrition the results were negative, eventually a concentrated spark was used on epithelioma and the discovery was made that it would shrivel up and die, gradually we have been using the process upon larger cancers until we have used it upon numerous cases of breast cancer and upon malignant tumors which were situated in other parts of the body. An apparatus of low potential especially for this work is required, which gives an exceedingly hot flame about three inches long.

Technic—The patient is prepared for the operation as usual and under full anesthesia. One pole of the apparatus is attached to a wet pad upon some part of the body, the other pole is applied from a point electrode throwing a flaming arc all over the diseased tissue. Immediately the tumor begins to shrivel and turns an ashen grey color, and when it is evident that the process is complete, the current is turned off and the mass can be removed immediately by the knife or left to slough, as may be thought best.

I have preferred the former method as convalescence is not so prolonged. It is to early as yet to speak of results as no case has passed beyond two years, I am very favorably impressed, however, by the process, and believe that where local it will kill the growth. I have used the process sixteen times to date and as yet have had but three recurrences. I submitted them again to the same process and am hoping for good results.

I am firmly convinced that we have not heard the last about these currents in cancer and a small change in technic may give a marked success. I was inclined to try it in

a bad case of cancer of the tongue in order to relieve the maddening pain and to try and change the character of the ulcer. The patient was not treated with any idea of benefitting his condition; I used a low potential but a high amperage current. A metallic electrode was placed in the mouth in contact with the cancer and the current was allowed to run twenty minutes dai'y. In two weeks it was evident that the tumor was softening and the ulcer was healing rapidly which continued until nearly a normal condition was brought about. One gland under the jaw subsided and to all intents and purposes the patient was symptomatically well and remained so for two years, when I lost track of him.

Several other cases have been tried with the same method and a general improvement has been noted although the results were not as favvorable as in the first case. It appears that the currents when concentrated upon a malignant tumor rather discourage the growth of cells and a recession takes place. It is not improbable that a continuous treatment of a cancer by this method might bring about a cure. It appears to me that medical electricians should exhaust their art in this disease as we have no thoroughly reliable method of treating these cases by other means. Surgery is now and has always been a failure in true cancer in spite of the wonderful statistics we get from time to time and just as long as we continue to play a losing game by ill-advised operations, just so long we will not make progress. That a real cure for cancer will be found I think no one questions. Just the character of the treatment necessary is not suspected at present but the immense amount of biological work now being done by different observers will unquestionab'y bear fruit at no late date.

High Frequency in Skin Diseases—It is in some of form of these troubles that the high frequency has served a useful purpose, apparently bringing about a cure after all other measures have failed. It is not like the X-ray, to be depended upon implicitly, as it is frequently dis-

appointing even in the simple case, while a hopeless, aggravated case will occasionaly recover under its applications so quickly and with so little complications as to seem little short of a miracle to the patient. The only charge that can be brought against this form of treatment is that it is erratic, it is not to be depended upon, while all operators claim it is promising, it has been disappointing. This is not surprising, however, when we take into consideration the huge amount of poor inefficient apparatus the manufacturers have succeeded in unloading upon the profession in the past, and it will be some time in the future before the last word can be said about the value of high frequency current in disease. Like the Finsen light, it will be in institutional work where it will reach its highest development.

In order to have sufficient current available it probably will be necessary to construct an apparatus in which the walls of the room are converted into a solenoid and resonator by carrying the windings upon suitable supports around the room; the condensors must be charged by closed transformers in order to use the commercial alternating current for the purpose, and then we can expect startling physiological effects from this modality. It is perfectly feasable to carry the oscillations so far that matter becomes luminous emitting a violet glow, a shadowless light, everything within the sphere of influence of the resonators glowing like the light of a vacuum electrode.

The expense for this style of high frequency would be too much for one man to assume, for that reason some institution or a religious hospital could carry on the work very well.

Lupus Erythematosis—Where this disease has resisted the X-ray, violet light and other means, we can occasionally cause a rapid cure to take place with the high frequency current. The results, however, are severely disappointing in seventy-five per cent. of cases, and no apparent reason has been discovered why this should be so.

Pruritus—The high frequency has earned some reputation in the treatment of this disease, but in my opinion is inferior to the X-ray, still many cases are reported by different operators and the subject wou'd repay further study.

Epitheliomata, Etc.—Small growths such as warts, moles and epitheliomata may be destroyed prompt'y with but little discomfort by using this form of energy. The mode of procedure is to construct an electrode with an open glass tube, a sliding wire with a rubber handle. The electrode is placed over the growth, and the wire placed so a spark one-sixteenth of an inch will pass from the wire to the growth, and then the current is turned on, a small amount of solenoid turns being used, in order to increase the amperage and decrease the voltage. A series of sparks is allowed to pass until the growth is seen to shrivel and die. The eschar is exfoliated in a few days leaving a perfectly cicatrized surface. Immunity from recurrence seems fairly assured, as no cases of return have been reported and the process is comparatively painless, very rapid in its action and may be carried on without difficulty by any operator.

Pigmented Nevi—Good results have been reported by different operators in the cure of this trouble, but in my hands it has proved an utter failure as I have obtained no results in about twenty cases treated.

Lupus Vulgaris—Success has followed its use in this disease in a few cases where the X-ray would not bring about a complete cure. Other operators have reported successes, but as a routine treatment so far, it has proved a failure. The technic used was the glass electrode with a rock crystal bottom, allowing the ultra violet rays to pass through, sufficient compression of the tissues being produced by the electrode. A later method has given much better results. An electrode is constructed in such a manner as to give a shower of small needle sparks, about 1-22nd of an inch long. This is passed over the ulcers until a surface eschar has formed. If this is followed by

an ointment of ung. hydrargyri nitras, applied until the eschar separates, reinfection is not likely. I have had several successful cases which were treated in this manner.

Tuberculosis—This subject will persistently bob up in the journals as being much benefited by high frequency treatment. Numerous reports of successes has been given to the medical press, since energy has begun to play such an important part in the treatment of disease. It is claimed by different authors, that the use of two large and powerful resonators with large spiked electrodes, will send this current through the chest, and aside from the well known stimulating effect of the current it is maintained that ozone and various nitrous products are liberated within the tissues. It is certain that the breath carries an odor of ozone after a prolonged treatment from a pair of resonators. It would be a hard question to decide without a very extensive experience just how much value it would have in this disease. It is a well known fact in medicine, that the condition of a patient's mind has more real effect upon tuberculosis than any remedy so far discovered. So far every procedure that has been tried in tuberculosis has a certain amount of success to its credit, and as long as the patients can be encouraged to believe that they can get well, and in fact make them believe they are improving daily, you will note a distinct gain in bodily weight, improved appetite and a diminution of cough and night sweats; on the other hand, if you let them feel that you think they are very bad, your efforts to build them up will be in vain as they can not get rid of that depressed feeling, and they gradually relapse into a state of despair. Patients that can be kept in a cheerful frame of mind will improve to a marvelous extent, and I have seen many of them recover permanently while being held in this condition. Reports that follow the use of a new agent are apt to be optimistic, coming as they do from the progressive, even if too enthusiastic operators.

I personally do not believe that any method can succeed in tuberculosis until the patient believes firmly that the treatment is going to cure him, and it is for this reason that patients in sanitariums invariably do better than in private practice, each person sustains his neighbor, while professional entertainers promote physical exertion and fix the attention of the mind upon anything but their own trouble, and in this way a successful outcome of the disease is probable.

The many successes reported regarding the treatment of tuberculosis will justify farther investigation as soon as more powerful resonators are available for use.

Progressive Muscular Atrophy—I have had fine results in three cases of this character where it seemed that the process would extend until the patient became helpless. In all three cases the process became arrested, and in two cases some regeneration took place. The treatment was administered by the Auto Condensation method. Several months were consumed before improvement took place.

Neuritis—The well known analgesic effects of the high frequency currents have been of value in this condition. The pain is lessened and a certain amount of regeneration takes place, but is of little value in traumatic neuritis following an injury to the shoulder joint, but gives more relief than any other therapeutic measure. It is good practice to combine the use of nitroglycerine in about 1-100 grain doses with the high frequency. Begin with one tablet every seven hours, and increase an hour every day, until the patient takes one every three hours. It may make the head throb violently, but persist in its use and success will be attained.

Pelvic Diseases—It has been found of extreme value in treating painful conditions of the pelves of women, the pain rapidly disappears, discharge is lessened and when followed by appropriate electrolysis, thousands of women can be saved from the surgeon's knife. It is perfectly practical and has become an established procedure to treat

suppurative diseases of the tubes and ovaries successfully by electrical means, and hundreds of operators are achieving marvelous successes along this line. It is not only a relief of pain but the infection is absolutely destroyed, adhesions softened or broken up, exudation absorbed and the woman made absolutely well as far as her own health is concerned or as far as any physician can detect. The procedure is so simple that any practitioner should be able to carry it out, and it has passed the experimental stage and become a fact.

Chronic Gonorrhea of both male and female has been treated by this current with a certain amount of success. Glass electrodes are used and the small amount of air retained around the glass is decomposed into ozone which is a powerful sterilizer, while the effect of the violet light directly upon the germs not within the tissues causes them to lose their vitality.

HIGH FREQUENCY IN INFLAMMATION.

Synovitis—In all its forms may be benefited and many times cured by the auto condensation method. Where there are adhesions with exudation, the treatment should be supplemented with massage and a hot air bath; of course, the operator should not except startling results in specific synovitis, either syphilitic, tubercular or gonorrheal, and he should be on the alert to differentiate these cases from the simple variety so often met with in practice.

Sprains—With pain and effusion are well treated with the auto condensation method supplemented with massage, a daily seance of from ten to twenty minutes relieves all pain and makes the patient comfortable.

Delayed Union in Fractures—Dr. H. E. Gauten reports a successful case where several operations were done without success.

Anemia—Following acute and chronic diseases at times we are confronted with a persistent anemia which does not yield to the ordinary ferrogenous tonics and

convalescence is much prolonged. In cases of this kind the auto condensation cage gives immediate and pronounced results. The patient is stimulated, appetite increased while the food is assimilated and a slow but persistent gain is noted.

Rheumatism—While the current is of little value in the acute form of the disease it is of unquestioned value in the sequelae that follows an attack of this trouble. The increased oxidation brought about, with the elimination of soluble wastes through the sweat glands and kidneys, improves the condition of the patient rapidly and prevents a relapse. The auto condensation cage is generally used for this purpose with a seance of from twenty to thirty minutes daily.

Arthritis Deformans—Several successful cases have been reported where the process was arrested and considerable improvement took place. Massage and the effluvia discharge were used locally.

Neuralgia—A great number of successful cases have been reported following the use of the local effluvia over the affected nerve. It is more than probable, however, that these cases were due to a local congestion. Physicians must not rely too much upon this modality in the treatment of disease without a careful physical and chemical examination. The urine should be examined for Indican and if present, attention must be given to the co'on, an enema twice daily of chloride of sodium is rather more likely to be beneficial to the patient, by flushing out the putrefactive material that is the cause of the trouble.

Headache—Where this trouble is due to a low urea index, due either to small kidneys or a defective thyroid gland, much relief and comfort can be found in this modality, using the auto condensation method of treatment. Of course, attention must be given to the thyroid and any deficiency made up and maintained if we expect permanent results. At times much temporary help in deficient kidneys can be had in sodium succinate given in five-grain doses every three hours.

It is difficult laying down didactic rules to follow in treating headache owing to the numerous causes for this condition. It is a reproach to our profession to think for so many years all our efforts have been directed towards finding a drug that would deaden pain and that until the last few years, we have been paying no attention to mending conditions that make headaches possible.

Many times a headache due to nitrogen poisoning is promptly relieved by a dose of thyroid extract, which in some unkown manner makes it possible for the body to reduce its nitrogen wastes to urea and favors its elimination through the kidneys.

If the profession is to gain favor with a large percentage of the public it must be by doing better work in the future. The great numbers of people who have joined Faith cults have not taken leave of their senses but are tired and disgusted looking for relief from their physical disability under our present archaic method of doing our work. It is wonderful how much a little laboratory work will accomplish in throwing light on the cause of many headaches and without its help no one ought to try and treat a case of this trouble. It is not good practice to give high Frequency treatment for a headache and fail to use a stomach tube where indicated to remove a mass of fermenting material, as the pain must be regarded as a friendly warning of poisons being absorbed that are harmful to the body. It would almost seem that the patient shou'd take warning even if it does not succeed in impressing itself upon the medical attendant. Many individuals are defective in deve'opment and the foramena that passes the nerves out of the skull are so small that when the blood is deficient in ca'cium an exudative swelling takes p'ace, interfering with the proper function of the nerve and setting up a train of conditions that will mean a headache if not corrected. In cases of this kind we must supply the proper calcium salt and we will terminate the trouble.

Ovarian, testicular and eye strain are frequent causes of the most malignant type of headaches and the mode of transmission is through the sympathetic nervous system. Usually we will find swellings very tender to pressure, in the cervical region which upon being rubbed down and an ice bag applied and the proper local treatment given to the offending organ, and we can stop the trouble in short order, as an auxillary treatment auto condensation is extremely useful, but it is not infallible, and will seldom take the place of painstaking laboratory work in placing the patient in such a condition that it will not recur at intervals.

In every case, the high frequency should be looked upon as a very useful agent. Curative effects, probably will require, in the majority of instances, in chronic diseases, the hardest kind of study on the physician's part.

Vaginismus—A painful, spasmodic condition of the vagina characterized by violent, painful spasms upon the slightest stimuli applied anywhere upon the surface. Many of these cases are persistent, and while unquestionably are due to violent abuse of an inexperienced husband, until the equally ignorant wife has been taught to regard all sensations in this part of the body as necessarily painful, until a neurosis eventually develops that makes the woman's condition a nightmare.

I had to bother with a case of this character for four years at one time and the woman was anesthetized several times while the muscles were stretched and eventually cut in order to do away with violent spasms, sometimes lasting for an hour at a time. She would fight her husband like a maniac and a piece of cotton on a toothpick would bring them on by simply stroking the mucous membrane. I was seriously considering cutting the pudic nerve when I concluded to try the high frequency upon the trouble. The first few times cocaine was used in order to induce her to let me try the method, and after a few seances she could tolerate the electrode

with no discomfort until in a few months the trouble disappeared.

Torticollis—Acute torticollis, coming on suddenly from exposure to a cold wind, will yield to the local effluvia over the affected part. In fact, it yields so quickly to treatment that it is doubtful if we have any other remedy to take its place. It is good practice to give massive doses of sodium salicylate per rectum and pilocarpine hypodermically until the sweat glands become slightly active.

Tinnitus Aurum—Some measure of success has been obtained by Coleman and others in treating this annoying condition, a consideration when we consider the great number of these cases that are unable to get any relief for their miserable condition. The vacuum ear electrode is used with the patient lying upon the auto condensation couch.

Ulcer—We have an efficient method of treating this trouble by using a metallic electrode like a wire brush and allowing a shower of minute sparks to play upon the ulcer. A slight eschar forms, which upon separating, leaves a clean wound. The same result can be obtained, however, with a saturate solution of nitrate of silver. applied locally, and while the latter is more painful it is much quicker in its effects.

Atonic Dyspepsia with Dilatation of the Stomach—Good results are occasionally obtained by placing a large electrode over the stomach and giving a prolonged seance daily, a slow but very marked improvement is certain. Other methods of treatment must be used if a permanent cure is desired.

Psoriasis—In this disease we occasionally get remarkable results, especially where we use a tube exhausted to the Crooke's vacuum with a cathode attachment. This gives a mild X-ray accompanying the high frequency current and many times we get brilliant results. It has been found a failure at times, however, and discrimination must be used in selecting cases.

Asthma—Theoretically these currents with their profound effect upon nitrogen metabolism should be useful, as this condition is unquestionably due to retained waste of this character and by using calisthenics to develop the lungs and using arsenic and quinine to prevent the active tissue changes a cure can confidently be expected.

Neurasthenia—Reports of good results in this trouble have appeared. The general lack of vitality noticed in these cases would not seem to indicate that this treatment would be useful. It is very doubtful if any treatment outside of getting back to first principles in diet and exercise, while a healthy mental action is cultivated, will ever do these people any good. I have had to care for many of them in late years and I have found as a general rule that we have to deal with a very selfish person, one in fact that has never learned the pleasure of sharing their orange with a fellow being, a morbid craving for sympathy is at the base of many of their trials and as a rule they are incurable until they can be convinced that there are other people in the world who are worse off than they are and whose burden can be lightened by a little help from them.

I am rather inclined to believe that a good tongue lashing properly administered and then send them to some of the missions to kill time, will bring about a quicker cure than the current.

Obesity—Several operators have reported remarkable results in this trouble by the auto condensation method of treatment, the results being due to increased nitrogen consumption. The method may be all right, but I think that a good phlebotomy followed by careful thyroid feeding will give quicker and more permanent results.

Lumbago—A powerful effluvia discharge from spiked electrodes has given marked relief and has apparently cured many cases. Massive doses of sodium salicylate per rectum with pilocarpine hypodermically will hasten matters and may cure a patient in twenty-four hours.

Insomnia—Auto condensation has given much relief in numerous cases of this aggravating condition. The lowering of blood pressure due to sedation of the sympathetic nervous system is one reason why we produce sedation of the nervous system.

Other Diseases—The High Frequency can be used with profit in any diseases characterized with nervous phenomena or defective elimination. It is of value in all recessional diseases where degeneration is in progress and nutrition is at a low ebb. No useful purpose would be served in naming all of them, as it is believed that any progressive physician will have no difficulty in selecting the proper case that is suitable for the treatment.

ELECTROCUTION.

Death from Electricity.

This subject has a fascinating interest to the public, and the exact mechanism of dissolution is not well known even by electricians. It has been the general impression that death is due to the voltage, and in newspaper reports of deaths, we are told that the deceased received so many volts.

To understand the fundamental principles that produce this phenomena, predisposes an accurate knowledge of all the laws governing electricity. We know experimentally that the body offers considerable opposition to the passage of a current of electricity, and that under certain circumstances, it is immune from a shock that otherwise might be fatal.

Death may take place in various ways with the current.

First, by shock to the nervous system, a sudden contact with an overwhelmingly large dose. The fright from the sudden contraction of the muscles, and the blinding flash may produce a fatal result in certain people, especially if something is wrong with their heart.

Second, by asphyxiation, due to the tetanic contraction of the muscles, which may remain rigidly contracted as long as the contact remains.

Third, by molecular disintegration, due to a very large volume of current passing through the body for a certain length of time.

Fourth, by inhibition of nervous impulse. If we send an interrupted current of the right period through the body, it will monopolize the natural highways of nerve transmission, and death will ensue from arrest of function of the heart and lungs.

In Death from Shock we must consider that the great majority are due to lightning. This is an oscillatory discharge of an enormously high voltage, great volume, and short duration.

It would seem from a theoretical standpoint, that no one could escape death who has been so unfortunate as to be converted into a lightning rod temporarily, yet we find few fatal results compared to the great number that are shocked yearly. The worst that the great majority of victims suffer is semi-consciousness and more or less of a burn. Usually reaction is rapid, and as far as I have observed, no permanent injuries have occurred. I have seen six people who have been through the experience and have observed that the surface of the body was covered with burns similar to the leaves of a fern. In three cases, the impression has been graven upon the skin, and have remained for a number of years, without loss of sharpness.

These markings are of the utmost importance to the scientific electrician, as they are analogous to those of a condenser discharge observed upon a photographic plate. It teaches us one truth—that the body has the ability to act as a condenser, and it is thereby protected from instant destruction. It is the induced change in the body that causes the current to take to the outer layer of skin in its path to earth, and prevents the disassociation

of the cells from the enormous amperage that accompanies the flash.

Instantaneous death has occurred repeatedly to one individual in a group, while the current has shocked other members, without serious consequences.

These results offer much difficulty in explaining, but probably can be accounted for on the supposition that the fatal cases were grounded, and thereby prevented the body from performing its function, by acting as a condenser. The nature of the shoes worn, the character of the place the victim happened to be standing upon, are all factors to be taken in consideration in each individual case and if known in each case accurately, the scientific electrician would have no difficulty in explaining why death took place.

In one instance that was called to my attention, four fishermen crawled under the dock to escape the storm, and were resting upon wet stones. A flash of lightning struck the pier, and all four were found dead. Their wet clothes, and the character of the ground they were standing upon, rendered the retention of a counter charge of electricity impossible, and the bodies absorbed the disrupted discharge. This would cause a violent oscillation, that would disturb the electrical equilibrium of each cell, and disassociate its atoms, thereby causing molecular or cellular death.

A like condition could easily be brought about by an accidental contact with the "B" circuit of a condenser of large capacity. Here the enormous amounts of amperage oscillating with tremendous frequency would cause disintegration of the cells, and would do great harm, and might cause death. In my experimental work, I have received an accidental shock from this circuit, from a condenser of moderate capacity, and have had occasion to remember it for several weeks, owing to the profound anesthesia of several important nerves.

Transformer Shocks—In these days of long distance transmission of the electric current for power purposes,

a new condition has been brought to the attention of attendants. It is no uncommon thing to step up to 40,000 volts, and with a large volume of current on the wire.

While these transmission lines are carefully protected from accidental contact, they have offered a strong fascination to many employes, owing to the peculiar condition of the human brain, this being day after day in a lonely power house, many miles from civilization, listening to the roar of the waterfall and the whirr of the machinery. The transmission line over which this enormous energy is sent, assumes a vivid fascination to its attendant, until he is possessed with a mania that eventually it is to be the cause of his death, and the silent wire is watched with a fascinating horror, until its victim is drawn irresistibly towards it. Many employes have been found who are unable to resist the impulse and have been found beneath the line dead and horribly burned.

Many cases that have come into contact accidentally, with help at hand, have lived to tell the tale. One, a notable case, happened in Brazil, where they have a long distance transmission line. The American superintendent was strolling through the plant with his wife, when he observed a switch which was not placed to suit his ideas of perfection. He reached up to shove it in, and immediately "froze" to the handle. He began to scream, and his wife, taking in the situation at a glance, backed off thirty feet and took a run with a flying leap and brought her body violently against his. This broke his hold, and they both reached the floor badly burned, but otherwise uninjured.

Many other cases have occurred, where help was at hand and the victim was rescued after a varying length of time, with nothing more serious than the burn. This teaches us that the primary danger of this class of currents is the tetanic contraction of the muscles, preventing the victim from letting go, after once in contact, until they are horribly burned and drop from the disintegration of the muscles alone. From the cases reported so

far, unconsciousness is not produced, and while a certain amount of anesthesia is present, all victims have screamed in agony.

This again is what we might theoretically expect from these currents, so that when death actually does take place, it is from asphyxia, and the disintegration from the current. One case is on record where an attendant was hung upon the wire for ten minutes, and no loss of consciousness ensued, but he later died from the burns received.

All of these transformers give an alternating current with a period of 25 cycles, and experiments made upon animals with a short circuit invariably seems to produce a spasm of the muscles. We can readily see that the voltage, while not harmless, that the actual damage is done by the amperage. The voltage, even with one milliampere, is sufficient to fix the muscles in a tetanic state, and will hold them in this condition as long as it is passing, but no bad results would ensue if it was not for the enormous amount of energy that the line is carrying at the time.

I was unfortunate enough to pick up a transformer shock by drawing an arc from a 60,000 volt machine, which had been grounded upon a bell line. My recollections are very vivid—a blinding flash, a violent contraction of the muscles, and a sensation as if a heavy weight had dropped upon both feet, without pain. This caused a violent palpitation of the heart for thirty minutes, and complete anesthesia of the lower extremities. A halo of lights were visible every time I closed my eyes, for several days. At no time did I lose consciousness, no pain was experienced, and, on the whole, the accident was not an unpleasant one. In this case, however, I was not in actual contact with the wire, but the shock passed through the fibre push button, and for this reason was only momentarily effective. That I received a great volume of current was shown by the absolute destruction of the bell wire.

Electrocution—At the time New York was contemplating the introduction of this agent as a means of capital punishment, many experiments were made to solve the many problems connected with this subject. At this time, electricians were under the impression that high voltage alone was all that was necessary to produce death. I well remember a series of experiments made by an eminent electrical engineer, trying to solve this problem. There was placed at his disposal a number of calves in order to allow him to carry out the experiment necessary to devise the proper machinery for the work. He wound a transformer to give 100,000 volts, with one ampere, and after it was finished, a calf was properly attached, and the circuit turned on. The calf, instead of dropping dead, as was confidently predicted, began to bleat and nearly wrecked the laboratory before the current could be turned off. He was not found to be any the worse for his experience, and after twenty minutes was contentedly eating with the rest of the herd.

A tap was taken off the transformer that gave 50,000 volts and another one was attached and the current turned on. He fell as if shot, every muscle in tetanic contraction, but evidently not dead and showing every evidence of fear. He was found none the worse after his experience, and another machine was constructed, giving 2,000 volts with 3 amperes. This was attached and the current turned on. The animal dropped suddenly, evidently unconscious, and the current was left for ten minutes and turned off. The animal was, to all appearances, dead, and another calf was taken to verify the experiment. The results were identical.

The success of our experiment rather enthused us with our discovery, and we adjourned to discuss the best arrangement of a machine for the purpose, and make arrangements to remove the dead animals. We returned in several hours, and found our dead calves much alive, and none the worse for their experience.

Several other experiments were made, with the current running a longer length of time, only to have our victim recover promptly within an hour, and we demonstrated the fact that the artificial respiration would restore them in a few minutes.

We next tried conecting them to a 1,000 volt arc light circuit, and found that death always took place, but, as was very evident, without unconsciousness, and very painful. That it required as much as four or five minutes before consciousness was lost in certain cases.

The next experiment was to give a 2,000 volt shock, producing unconsciousness, and then reducing the voltage to 1,000 volts for five minutes, and this was generally fatal, although several cases were resuscitated by artificial respiration.

We then gave a 2,000 volt shock for 30 seconds, 1,000 volt shock with low ampereage, so as not to cause burns, but fixing respiration, for 40 seconds, and dropped the voltage to 500, and allowed a heavy current to traverse the body for 40 seconds. This disintegrated the cell, and no effort we ever made saved a single animal after it had gone through this procedure. A slight modification of this method was finally adopted. First, a shock of 1,800 volts for 30 seconds, 1,000 volts for 40 seconds, and 650 volts for 40 seconds, causing molecular disintegration.

The first shock produces unconsciousness, the second fixation of respiration, and muscular contraction, and the third decomposition of the cells, liberating the oxygen and hydrogen, and the tissue presents an emphysematous condition, due to the retained gas.

There is one case on record where death took place in a child on a power circuit of 115 volts, the contact being made through the head, which became wedged between two parallel bare wires in a factory. Under ordinary circumstances, death could not take place from a circuit carrying this voltage. An electrician can readily conceive of conditions where it might do so by proper preparation.

When we use a 220 volt circuit, we are coming within the range of the real danger zone of electricity, and for this reason, this voltage is high enough to overcome the resistance of the body under ordinary conditions and allow an enormous amount of current to pass through. At this pressure, the current will pass readily, and for this reason, electrolysis of the tissue takes place. The time of contact, and the volume of current the wire is carrying, will determine the amount of destruction of tissue, and settle the question of death. This current would produce horrible burns, owing to the great difference in resistance the tissue offers, compared to the wire.

Few people have come in direct contact with a railroad circuit at 500 volts, and lived to tell the story. The enormous volume of current carried by these transmission lines and at a voltage that breaks down all barriers to the entrance of the current, allows enough wattage to pass through within a very few seconds to produce extensive structural changes, so great in fact, as to be incompatible with life. Many of the workers around these power plants receive shunt shocks, by becoming a by-pass of high resistance, and allowing a comparatively small amount of current to pass through them. These shocks may become exceedingly disagreeable, and have been known to produce bad burns, but seldom cause any serious lesion, owing to the relatively small amount of wattage absorbed.

Flash Burns—In railroad work, many employes receive serious injuries in a peculiar way, called a flash burn. These injuries are received in many ways, and produce peculiar lesions. The act of uncoupling the electrical connection between cars with the current on the conductor, is frequently followed by a blinding flash of incandescent metal. It has all the volume of an explosion on a small scale, and is so vivid and hot that blindness may follow for a short time, followed by an obstinate conjunctivitis, owing to the great volumes of ionic metal driven into the tissue. The surface of the body exposed shows a

violent erythemia, considerable thickening of the skin, giving to the touch the sensation of leather. Some vesication may occur, but is rare. A peculiar depression is noticed in the patient, the tongue is coated, temperature about 100°, loss of sleep, and persistent neuralgic pains.

If the flash was not very great, resolution begins in seven days, and proceeds rapidly, so that the victim may have fully recovered in four weeks. I have known two cases where the blindness persisted for over one month, and some remains of the conjunctivitis remained for over six months.

Injuries similar to these are frequently received in pulling switches on a heavy railroad circuit, or by the sudden blowing of some of the various types of explosion fuses now used on street cars. Numerous cases of injury are due to the breaking of a trolley wire, and the swinging ground produced. The broken end striking the ground or rail, is thrown off with explosive violence, making and breaking a contact, emitting brilliant flashes of incandescent metal. Many people have complained of injury, and suits brought against the company, alleging blindness or deafness and other nervous injuries as being received by being in the neighborhood when the accident happened.

Many experts were under the impression that it was a plain case of maligning, and have so testified in court. Investigation, however, shows a wonderful agreement in the statement of injuries by different persons, separated by many miles from each other, and having nothing in common, and all of these people agree on practically the same train of subjective symptoms—transient blindness, lasting for from 24 hours to three weeks, impairment of hearing generally present, and the impairment of the nervous system and more or less loss of nervous energy.

I have had the pleasure of studying four of these cases, both before the case had got into court and years after a verdict was rendered, and the whole matter was settled as far as the patient was concerned. Some of the people I had known for several years before the injury was re-

ceived, and I am reluctantly compelled to admit that it is a condition not met with under any other circumstances. No astounding recoveries have followed the rendering of vedicts, either for or against the patient.

A typical picture is presented in the following case—A young lady, 19 years old, who was a bookkeeper, while coming down the steps of the elevated railroad at 7 A. M., a trolley wire broke in the street, fell on a horse, and killed it instantly, bounded off from the horse, struck the rail, emitting a hissing flash as it flew into the air, within five feet of her face, fell to the ground at her feet, and flashed off in the air again. She was pulled forcibly away by a bystander, and found herself blind, so that she had to be sent home in a cab. The eyes were violently inflamed, and she was totally deaf in one ear. She was moaning with pains of a neuralgic character so severe that she would wake with a scream. A rapid loss of flesh was noticed, and a temperature, varying from 100 to 102°, tongue coated, nauseated, with foul-smelling stools. She complained of a severe pain in her head that lasted for over three months. She was practically unconscious for eight days, and when she came to, she had a clear knowledge of what had occurred. She was not frightened or horrified at what was occurring, but was enjoying the excitement as only an up-to-date Chicago girl can, and no thought of danger entered her mind. She says she did not receive any shock, but felt suddenly a sensation as if someone had thrown a handful of sand in her face. This was followed by a warm sensation all over the body, and for an instant she did not realize that she was blind.

In her case, she recovered the use of one eye in ten days and the left one in twenty-eight days. She was confined to her bed for eight weeks, and has not been able to resume her occupation since, now over seven years. The whole character of her physical make-up changed after the injury was received. She was a robust, rollicking city girl, always full of life and spirits, with the exception of measles and mumps, escaped other childhood

diseases. Following the injury, she lost thirty pounds, has remained depressed, and has never recovered her vitality. She has lost all of her vivacity, and takes little interest in her surroundings.

Now, some of our paid neurologists and experts would have no difficulty in explaining this condition on the theory of hysteria, and this term hides a world of ignorance under a scientific mantle. In this case, the girl had been my patient since childhood, I know her as well as my own children, and to me it is inconceivable that hysteria had anything to do with the matter.

In another case, a telephone girl had a receiver burn out by the line coming in contact with an arc light circuit. She developed the same train of symptoms, and degenerated into the same physical condition. In her case, the element of fright could have been a causative factor, inasmuch as she had a severe burn upon the ears, and described the experience as a sudden, violent blow from a club on her head. She has remained totally deaf four years after the case was settled in court.

I have been consulted by five other cases that presented the same history, and while seven cases are not enough to establish the condition as a complete clinical entirety, the presumption is great that gross lesions have taken place, that will require a few autopsies to clear up the pathology that may be present.

It seems certain that there is an active cause in connection with a broken power wire, as the same train of symptoms are never seen under any other conditions. If we consider the conditions surrounding a wire under these circumstances, we can gather some information, as to what may take place from the experimental evidence to be obtained. While I have never had the privilege or opportunity of experimenting with the direct current, I have carried on a series with a step-up transformer on the alternating current, carrying only a few amperes. One terminal was grounded and a mechanical ground was established, so as to regulate the period during which it

would occur. Gelatine dishes were exposed where the arc was occurring and tested for copper. It was found that when the grounds were sufficient to render the copper incandescent that dishes ten inches from the arc showed a green color, on the addition of a dilute sulphuric acid. Moreover, an induced current of great intensity was collected by a condenser located ten feet from the arc. If this can happen with a transformer of small volume, how much farther would the copper be thrown when a power current carrying over a thousand horse-power was suddenly grounded, raising the wire to incandescence instantly, and acting with explosive violence as it formed an arc; the copper ions being thrown off in great volume, rendering the air a good conductor, the volume of induced charge might be great enough to produce gross pathological changes.

A series of experiments should be conducted on animals, by some experimenter with the proper facilities at hand to determine these factors. Application for the privilege has been refused with considerable vehement enthusiasm by those in a position to grant the privilege, and I have a faint suspicion that railroad managers are not anxious to have problems of this kind solved, as they have had to pay verdicts for nearby injuries, and will object strenuously to paying long distance ones if they can help it.

Death by Inhibition or Nerve Impulse—If we refer to the article on electric sleep, we will learn that death is possible by sending a succession of electric impulses over the central nervous system which will supplant the regular transmission of nervous impulse, and death will ensue from the arrest of action of the heart and lungs. This may be accomplished with about eight volts and four milliamperes. We generally consider the alternating current to be more harmful than the direct, not that it will kill as quick, but it has been found impossible to let go of a wire carrying the alternating current, owing to the tetanic contractions of the muscles, and the profound pathological

changes brought about in the nervous system. A fair contact for a certain period with a sufficient amount of this current, does irreparable harm to these structures, if it fails to produce death. This is owing to the oscillation disturbing the electrical equilibrium of the cells, and causing their disintegration.

The period used in commercial practice, rarely produce unconsciousness, and the victim suffers until death comes to his relief. I have been told by linemen who have seen their partners destroyed on these wires that they have continued to scream for several minutes before death claimed them, and in several instances, all the clothes were burned off from their body before they were released from the wire.

From the foregoing, we can realize that the voltage plays only a subordinate part in a fatal result, as we can under suitable conditions cause death by using a voltage of from 8 to 1,000,000, it being only on rare occasions where either the lower or higher voltage can overcome the resistance offered by the body, so that death can take place. In the lower voltage, the resistance is so great, very little current can enter, while with voltages over 2,000, the body becomes so good a conductor that little resistance is offered, and electrolysis or destruction of the cells rarely occur, and the higher the voltage, the less real danger will take place. For practical purposes, we can consider a power circuit carrying a voltage of from 250 to 2,200 as being extremely dangerous to life. Voltages below 250 can seldom open the body to the passage of a great amount of current, while voltages about 2,200 overcome the resistance to such an extent that the body carries the current readily and disintegration from electrolysis does not take place. The outer skin carries the greater volume of current under these conditions, owing to the body generating a counter electromotive force, and acting as a condenser.

Under the circumstances, should a physician bring a current of this kind into his office, if it is the only source

of energy available to operate machines, by all means have it installed by the best electrician to be had, and thoroughly inspected before it is used. It is far better to bring the current to the outside of the house and bring a shunt circuit inside for our purposes. It is impossible to avoid a shock occasionally with medical apparatus. The general use of binding post connections, and the necessity of working in the dark occasionally renders a physician peculiarly liable to an accidental contact. The welfare of the office attendants requires some consideration, and if great care is not used in installing the apparatus, a dangerous ground may be accidentally formed.

Electric Sleep—The possibility of producing anesthesia by electrical means has always been one of fascinating intrest, and has cropped out in various forms, to have a brief existence, and again go into oblivion.

About twenty years ago, an apparatus was devised for the use of both the surgeon and dentist, to enable them to perform operations under the influence of an electic anesthesia and in the state of general public knowledge in handling electricity, it bid fair to be a great success. Unfortunately, however, the apparatus was run with batteries and it fell into disuse as soon as the batteries were used up, owing to the fact that the firm failed that made them.

I observed the apparatus in operation in many dental offices. Few surgeons used, or would try them, as this class of people are very cautious when it comes to absorbing a new idea.

Within the last year, however, Dr. Stephen Leduc of Nantes, revived the idea, and was probably the first one to actually go to sleep with the method. The general principles were the same in the earlier attempt to use this apparatus, and at that time general anesthesia was induced in animals.

In general, it means the use of a rapidly interrupted galvanic current, with the negative electrode upon the forehead and the back of the neck, while with the earlier

apparatus the positive pole was connected to the dental forcep or surgeon's knife. With adults, about two milliamperes of current was required to produce a painless extraction.

The current may be obtained from any direct source, but must be passed through a special interrupter to give the necessary number of breaks. Prof. Leduc prefers a period of contact of .01 second, current 1-10 of period, and a pause of 9-10 of the period. He applies the negative electrode to the forehead and the positive at the base of the spine, or any other suitable position, and gradually turns on the current until anesthesia is produced. As a slight increase in current will arrest the respiratory center and cause death, after the correct amount of current necessary to produce anesthesia is learned, it can be produced suddenly by turning the current on, when the animal drops suddenly unconscious, and may be maintained in this condition for eight hours, and wakes up suddenly, with seemingly no discomfort when the current is turned off. He may be submitted to the process several times in twenty-four hours without suffering any harm. if a short period of rest is given between times.

Attempts have been made to explain the phenomena by claiming that the oscillations tire the nerve. No such an effect has ever been noted in a nerve, and the probable effect is due to a clogging of the nerves by the rapidity of the oscillations, and prevents any normal sensation from being transmitted over that particular nerve.

If the period of interruption of the current is reduced to about 500 a minute, epileptiform convulsions are induced that resemble a genuine attack of epilepsy.

Many physicians have maintained that the current does not penetrate the skin, but travels over the surface of the body. Most therapeutists demonstrate every day the fallacy of this idea, as a slight abrasion of the skin will reduce the resistance to such a degree that all the current will follow it in, and cause a serious irritation.

A series of experiments were carried out upon animals in order to determine what tissues were traversed by the current. They were given a large dose of morphine to lessen sensibility and a negative electrode was placed over a shaved cranium, and large copper electrodes wet with copper sulphate was attached to the hind legs. Ten milliamperes of current were allowed to run for some hours, when the animal was chloroformed and a post mortem made. Sections made along the probable course of the current, a distinct copper reaction was found throughout the nervous system, and the brain was very rich in copper. The muscles in the immediate vicinity of the copper electrode showed a decided reaction. Sections of the spinal cord made at different places showed that copper was present.

The experiment was varied, and the sciatic nerve was exposed in a dog, who was under chloroform, and a copper needle was inserted into the muscle close to a nerve. The current spread out until the nerve was reached, and the nerve showed copper throughout its length, while the muscles showed it for a short distance only.

Leduc gives the following directions to produce electrical sleep: A shunt controller, a source of energy, a pole changer, a milliampere meter and a volt meter. The animal's head is shaved, and a thick piece of absorbent cotton wet in a salt solution 1-100; upon this cotton a flexible electrode of metallic tin is connected to the negative pole.

The larger electrode is connected to the positive pole, and may be placed upon any portion of the body upon the same side. It is advisable to place it at the base of the spine so as to include the spinal cord, the cerebrum and the cerebellum. If we desire to exclude these parts, it must be placed upon the anterior part of the body.

The head is connected to the negative pole, in order that its potential may not vary. The current depends upon the alternatings of potentials at the positive pole,

which is high when the circuit is closed, and falls suddenly when the current is broken.

It is possible to produce sleep by connecting the positive to the head, but a greater voltage, more current, and the sleep is not so profound. The arrangements being made, the interrupter is started: the current is regulated in regard to both its period and frequency.

We commence by gradually raising the potential at first quickly, and afterwards slower. There is a period of excitement as in other narcotics and anesthetics, that seems to be unavoidable, as we gradually increase our potential, it loses in intensity as it gains in duration. By adding one volt in 60 seconds, it will produce less excitement than if done in one second.

Sleep follows the excitement, and for this reason we must carefully raise our potential. The animal without pain, a cry or movement, drifts off into profound slumber, similar to chloroform or ether. The reflexes are not abolished if the spinal cord is not included in the circuit. The animal does not respond to any stimulant and appears in a profound anesthesia.

It requires from 6 to 8 volts to produce this sleep in rabbits, and from one to two milliamperes of current. When we have ascertained the necessary voltage to produce sleep, it may be thrown in suddenly. The animal falls to its side, stiff and motionless, owing to the general muscular contraction. In about ten seconds, relaxation occurs, and in 15 seconds respiration begins, and the animal may be kept in this condition for a number of hours. The experiment can be terminated immediately if desired, by suddenly cutting off the current, when the animal regains its feet, with neither pain or fear, looks generally about, and begins to play as soon as the electrodes are removed.

When we have produced profound anesthesia, we can arrest respiration by raising our voltage slightly, and in a rabbit ten volts will cause death. By increasing our voltage, the respiratory center is stimulated, and increased

respirations and increased in volume. Later they become more irregular, losing steadily in volume until the movements are arrested with a complete relaxation of the chest.

The function of the heart is not altered for a period of twenty seconds. If the current is suddenly cut off, a deep respiration takes place, and it slowly regains its rythm. The respiration may stop for a minute or more, without seriously affecting the movement of the heart.

The safety of the procedure is very great when proper care is used. In a series of 74 experiments made in order to study the action upon the respiration and circulation only, seven deaths resulted. Of these, they produced five of them intentionally in order to study the circumstances in which they were produced. The other two cases occurred while studying the respiratory effect. Of all the animals used to study the respiratory movement, only one was found dead in its cage the following day.

Resuscitating Animals from Apparent Death—Where the procedure has been carried far enough to stop the respiration, and it is not re-established upon breaking the current, allow the connections to remain the same, but alter the rythm, by making the contacts the same ratio as respiration. They were successful in reviving animals under this condition.

Blood pressure falls after full anesthesia has been produced, but regains quickly when the current is broken. Sudden anesthesia produces in animals an evacuation of both the bowels and bladder. The temperature is usually subnormal, and the pupils contracted.

Leduc reports upon his own sensations while undergoing the experiment, sensation produced by the stimulation of the superficial nerves is easily borne, but quickly subsides and gradually grows less. The face reddens, the muscles of the face, neck and upper arm twitch, and have a trembling sensation. Twitching sensations of the feet and hands, and general motor inhibition and no reaction is produced to any painful stimuli. These may be in-

tense, but give no facial expression of pain. The pulse remains unaltered, and only a slight interference with respiration is noted, when the current reached its maximum. He heard voices as in a dream of those around him and felt his incapacity of moving. He felt the contractions of his upper arm, but the sensations were benumbed. The most painful experience was the gradual leaving of the faculties. It resembled a nightmare, in which one feels in danger, yet is unable to cry out or move.

In three experiments made upon him, no one completely deprived him of consciousness. No bad results were noted.

Local Anesthesia.—By placing the cathode on the wrist and the anode upon any convenient part of the body, we can cause anesthesia of the medium nerve.

ILLUSTRATIONS

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